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PROCEDURES FOR EVALUATING OPERATIONS OF AMBIENT AIR MONITORING NETWORKS
A Manual

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This manual is designed to evaluate the efficiency of ambient air monitoring networks whose primary objective is to document compliance with or progress toward attaining ambient air quality standards. The manual provides methods to evaluate the efficiency of each of six operational areas: Network Plan and Design, Personnel Qualifications, Facilities and Equipment, Sampling and Analysis, Quality Assurance, and Data Utilization. A technique is presented for the overall integrated evaluation of the operational areas. A final section provides methods to evaluate the efficiency of budgetary allocations.

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DISCLAIMER

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PREFACE

The procedures detailed herein are a "first cut" at the development of a mathematical basis for the evaluation of monitoring network operations. Since the relative importance of the components of network operations is a function of monitoring network objectives, no single evaluation technique is universally applicable. For this reason and because of the complex nature of this subject, the evaluation methods developed herein are applicable only to monitoring networks whose main objective is to document compliance with or progress toward attainment of promulgated ambient air quality standards and/or regulations.

A necessary restriction placed on development of this evaluation procedure was that it be consistent with existing regulations promulgated by the U.S. Environmental Protection Agency (EPA) concerning site selection, network design, sampling methodology and quality assurance procedures. Substantial changes in these regulations will require modification of the evaluation procedure.

Identification of the six major operational components of an air-quality monitoring network with the stated main objective was accomplished by an on-site study of five networks judged by the EPA Regional Offices to be among the best operating networks. The major characteristics identified are: 1. Network Design, 2. Personnel, 3. Facilities and Equipment, 4. Sampling, 5. Quality Assurance, and 6. Data Distribution and Dissemination. While the on-site studies served to identify the operational components, they did not provide sufficient data for a mathematical assignment of the relative weights for these components. To provide the latter the opinions of governmental experts in the monitoring field were solicited and the results statistically analyzed. Values of the weighting factors so derived have been carried to the third decimal place because these factors are normalized values of over 55 responses. It will be noted, therefore, that users of these evaluation techniques will be comparing the operational characteristics of their networks against a mathematically derived function of the opinions of over 55 experts. While this approach admittedly has drawbacks, it is, as stated, a "first cut" approach. A separate document describing the mathematical treatment of the expert opinion data and derivation of the relative weights of operational components will be furnished, upon request, by the Project Officer at the Environmental Monitoring and Support Laboratory, Las Vegas (EMSL-LV).

Finally, it will be noted that application of this procedure is complex and can be carried out only by personnel directly involved in operation of the monitoring network. Depending on the magnitude of the network it may indeed require inputs from several individuals with a total manpower investment of up to 5 man-days. This latter, however, is a small price if it leads to a more technically optimum and cost-effective monitoring operation.

The procedures in this manual have not been field tested; however, such an evaluation is planned for the immediate future. In the interim we encourage users of this manual to submit their observations and suggestions for improvement.

CONTENTS

		Page
Disclaimer		ii
Preface		iii
List of Figures		vii
List of Tables		viii
List of Abbreviations and Symbols		ix
Acknowledgment		x
I	Introduction to the Manual	1
II	Evaluation of Network Plan and Design	11
	II.A Rating for Number of Monitoring Sites	11
	II.B Rating of Site Distribution	26
	II.C Rating of Site Characteristics and Design	31
	II.D Evaluation of Network Planning and Design	36
III	Evaluation of Area of Personnel Qualifications	38
	III.A Education Rating	38
	III.B Experience Rating	41
	III.C Special On-Job Formal Training Rating	44
	III.D Evaluation of Personnel Qualifications	47
IV	Evaluation of Area of Facilities and Equipment	48
	IV.A Office Facilities and Equipment Rating	48
	IV.B Rating of the Wet Laboratory	48
	IV.C Rating of Calibration/Maintenance Facilities	48
	IV.D Field Facilities Rating	51
	IV.E Field Instrument Rating	53
	IV.F Evaluation of Area of Facilities and Equipment	56
V	Evaluation of Area of Sampling and Analysis	57
	V.A Rating of Recording Procedures for Continuous Sensors	57
	V.B Rating of Use of Station Operator Time	60
	V.C Area Evaluation	63
VI	Evaluation of Area of Quality Assurance	64
	VI.A Ratings for Controls on Field Instruments and Measurements	64
	VI.B Ratings for Controls on Laboratory Instruments and Measurements	67
	VI.C Evaluation of the Area	69

CONTENTS (continued)

		Page
VII	Evaluation of Area of Data Utilization	70
VIII	Overall Area Evaluations	72
IX	Evaluation of Technical Services Budget Allocation	73
	IX.A Budget Allocation Rating Determination	73
X	References	77
	Appendix A	78

LIST OF FIGURES

Number		Page
1	Rating curve for the number of sites for each pollutant	23
2	Case a. Priority I for TSP and SO_2	27
3	Case b. Priority I for Oxidants and/or CO	27
4	Case c. Priority I for pollutant mix other than case a or case b	28
5	Case d. Priority II and/or III for all five major pollutants	28
6	Rating for site distribution in each AQCR	30
7	Nomogram for evaluation of network plan and design	37
8	Experience rating curve	42
9	Rating for on-job training program	45
10	Rating for efficiency of use of station operator time	61
11	Days between end of period and summary release	71
12	Determination of technical services budget allocation	74
13	Personnel budget allocation rating	76

LIST OF TABLES

Number		Page
1	Network basic information	3
2	Technical services personnel information	10
3	Zone areas and pollutant concentrations	13
4	Number of monitoring sites for SO_2 and TSP	14
5	Minimum number of air quality monitoring sites as a function of concentration levels and population	16
6	Required minimum number of monitoring sites based on AQCR classification and population	18
7	Topography and climatology	20
8	Determination of the number of sites for photochemical oxidants and NO_2	21
9	Actual vs recommended numbers of sites	23
10	Rating of the number of sites per pollutant	25
11	Multiplying factors for four cases of air pollution	25
12	Station distribution work sheet	29
13	Sampling location guidelines for areas of estimated maximum pollutant concentration	32
14	Ratings for site characteristics and design	34
15	Ratings for office facilities, wet laboratory, calibration/maintenance facilities	49
16	Values for field facilities	52
17	Rating for field facilities	52
18	Rating for intermittent sensors as applicable	53
19	Rating for continuous instrument performance parameters	55
20	Evaluation of continuous sensor recording procedures	58
21	Evaluation of station operator time	61
22	Ratings for controls on field instruments and measurements	65
23	Ratings for controls on laboratory instruments and measurements	68
24	Area of quality assurance evaluation	69
25	Ratings for data utilization	71
26	Network evaluation	72

LIST OF ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

AQCR	--	Air Quality Control Region defined in the Federal Register, Vol. 40, Part 35.501-4 (1972) as an area designated or established pursuant to Section 107 of the Clean Air Act (Dec. 1970). Section 107ff of the Clean Air Act states that air quality control regions are geographical regions for which implementation plans exist specifying the manner in which national primary and secondary air quality standards will be achieved and maintained.
avg.	--	average
calib. freq.	--	calibration frequency
Hi-Vol.	--	high volume air sampler
Hq. digit. acquis.	--	digital acquisition system at Headquarters
km^2	--	area in square kilometers
Mfr.	--	manufacturer
mg/m^3	--	milligrams per cubic meter
$\mu g/m^3$	--	micrograms per cubic meter
ppm	--	parts per million
spec	--	specification

SYMBOLS

CO	--	carbon monoxide
NO_2	--	nitrogen dioxide
OX	--	photochemical oxidants
SO_2	--	sulfur dioxide
TSP	--	total suspended particulates

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Many individuals at the five networks visited and the experts who responded to a Survey Letter have been helpful in developing the material used in these recommended procedures. For their contributions, the project management extends its sincere gratitude.

Mr. Edward Schuck, U.S. Environmental Protection Agency, served as Project Officer, assisted by Mr. Leslie Dunn and Dr. Joseph Behar. Mrs. Ruth W. Shnider, URS Research Company, served as Project Manager. Mr. Jack Jenkins, who visited and compiled information on the operations of five air monitoring networks, provided valuable input and assistance on this project, and Mr. Paul Kennedy also aided in the evaluations of laboratory instruments and facilities.

SECTION I

INTRODUCTION TO THE MANUAL

This manual is designed to evaluate the efficiency of ambient air monitoring networks whose primary objective is to document compliance with or progress toward attaining ambient air quality standards. This definition includes the ambient air monitoring operations of networks that include Engineering and Enforcement, although the latter two functions are not examined except in consideration of overall budgetary allocations. The evaluation is designed to be carried out for a network consisting of one Air Quality Control Region (AQCR), or for a network consisting of a number of AQCRs, since the basic methodology evaluates each AQCR individually. For networks composed of more than one AQCR, methods are given to integrate the results for all AQCRs into one evaluation.

Two basic concepts are used in the evaluational methodology: (1) air monitoring operations depend mainly on the population density, industrial and commercial distribution, and the meteorological and topographical constraints; (2) the overall efficiency of a network is the integrated result of the evaluated efficiency of each area of operation within the network. Six Operational Areas have been designated: Network Plan and Design, Personnel Qualifications, Facilities and Equipment, Sampling and Analysis, Quality Assurance, and Data Utilization. The first six sections of the manual provide methods to evaluate the efficiency of each of these areas, and the seventh section presents the technique for the overall integrated evaluation of Operational Areas. The last section provides a method to evaluate the efficiency of budgetary allocations. Most of the areas are composed of many elements. The efficiency of all elements must be integrated to evaluate each area efficiency, and the efficiency of all the areas must then be integrated to evaluate the network efficiency. The manual presents techniques for each of these integrations.

The sections of the manual are numbered in Roman numerals. Evaluations of elements comprising each area are identified by the sectional Roman numeral and a capital letter. For example, Section II provides a method to evaluate the area of Network Plan and Design. The number of sites in a network is one element of this area. Thus, Rating for Number of Monitoring Sites is identified as a subsection II.A. Subsection II.A. is then subdivided into four parts. II.A.1, II.A.2, and II.A.3 contain instructions (taken from U.S. EPA, 1974) to calculate, by three different methods, the number of sites needed to monitor the five major pollutants. II.A.4 presents a technique that combines the previous three methods and provides a rating of the existing number of sites per pollutant with respect to both EPA recommendations and the pollutant priority classifications for each AQCR. Only the five major pollutants for which Federal Regulations have been promulgated are considered. These are: total suspended particulates (TSP); sulfur dioxide (SO_2); carbon

monoxide (CO); nitrogen dioxide (NO_2); and photochemical oxidants (OX). The Rating of Site Distribution is a second element of this area, and the method for rating this element is labeled II.B. A technique for rating the element of Site Characteristics is identified as II.C. The last subsection, II.D., provides a method that combines the ratings of the three elements in II.A., II.B., and II.C., into one overall evaluation for the area of Network Plan and Design. Each succeeding section is similarly subdivided.

Weighting factors are used in achieving each evaluation. These factors are normalized mean values derived from analyses of responses to a Survey Letter that requested experts in the field of air monitoring to designate the weighted relative importance of most of the items considered. All weighting factors are decimal fractions (less than 1.0, since they are normalized values); however, they represent very real differences in the opinions of over 55 experts in the field of air monitoring. Specific regional requirements were accounted for by special utilization of the responses, which were obtained from all over the United States.

Calculations required to derive the ratings are presented in "Steps" to clarify the processes and aid the evaluator, and tables are provided for recording the rating calculations. Each of these tables contains space for six AQCRs, to be used as needed for the network considered.

This manual is the first of its type to provide a method for evaluating ambient air monitoring networks in this fashion and is designed to allow completion within a week. There are, naturally, limitations to the manual. For example, the only bases for comparison and evaluation in many cases are current EPA-recommended procedures and approved instrumentation. Consequently, the manual will require updating as changes are published in the Federal Register. Furthermore, only general site distribution rather than precise location is considered in the area of Network Plan and Design, since analyses of meteorology and emissions distribution are beyond the scope of this manual.

Tables 1 and 2 of Section I, when completed, will contain information needed in the Evaluational Sections that follow. Most of the information for completing the tables should be available in the files of the headquarters office of the network under study. Some inspection will be necessary to complete the information on Facilities and Equipment in Table 1. U.S. EPA Guidelines APTD-1347, 1972, and the maps noted in Section D of Table 1 will also be needed along with knowledge of the Federal Register, 40 CFR, Sections 50 (1971, amended 1975b) and 53 (1975). After obtaining the necessary maps and completing Tables 1 and 2, the evaluational procedures described in the manual can be carried out readily. It is anticipated that completion of the information tables will require about 3 man-days and the evaluations can be completed in 2 man-days.

In many cases non-metric units are employed because data, such as area on a map, or recommended values in referenced EPA documents (hereinafter referred to as Guidelines), occur in those units. Conversions to International System of Units (SI) are provided in Appendix A.

TABLE 1. NETWORK BASIC INFORMATION

Air Monitoring Agency _____ Area of Network _____ sq. mi. No. AQCR's in Network _____

Indicate whether major network emphasis is: Ambient Air Monitoring _____

Enforcement _____

A. BUDGET INFORMATION

Total Budget $_____

		Administration and Public Information	Technical Services Air Mon., Lab, Data Anal.	Engineers/Enforce.	Total Itemized
1.	Budget for Activity	$_____	$_____	$_____	$_____ (Total Budget)
2.	% of Total	_____ %	_____ %	_____ %	
	Personnel				
3.	Salaries and Benefits	$_____	$_____	$_____	$_____
4.	% of Activity Budget (1)	_____ %	_____ %	_____ %	
5.	% of Total Budget	_____ %	_____ %	_____ %	_____ %
	Equipment				
6.	Capital Expenditure		$_____		
7.	% of Activity Budget (1)		_____ %		
8.	% of Total Budget		_____ %		

B. PERSONNEL INFORMATION

1. List Total number of personnel in Technical Services (Air Monitoring, Laboratory, and Data Analysis) _____.
2. Obtain copies of the network Position Descriptions for each Technical Services position. For each filled position, complete columns 1 through 8 of Table 2.
3. Does the network provide special On-Job Formal Training Programs? _____.

TABLE 1. (continued)

C. AIR MONITORING SITE INFORMATION

1. Fill in the information for each AQCR in the network.

	AQCR					
	1. Priority Classification I ____ II,III ____ Pop.	2. Priority Classification I ____ II,III ____ Pop.	3. Priority Classification I ____ II,III ____ Pop.	4. Priority Classification I ____ II,III ____ Pop.	5. Priority Classification I ____ II,III ____ Pop.	6. Priority Classification I ____ II,III ____ Pop.
Area (sq.mi.)						
No. of sites w/Envir.Control						
Number of sites with continuous sensors	digital acquis. at each station / Telemetered Hq digit acquis.	digital acquis. at each station / Telemetered Hq digit acquis.	digital acquis. at each station / Telemetered Hq digit acquis.	digital acquis. at each station / Telemetered Hq digit acquis.	digital acquis. at each station / Telemetered Hq digit acquis.	digital acquis. at each station / Telemetered Hq digit. acquis.
Frequency of cont. Sensor visits	per week	per week	per week	per week	per week	per week
Servicing						
No. sites with both intermittent and continuous sensors						
No. continuous sensors						
No. of sites monitoring each pollutant TSP, SO_2, CO, NO_2, Oxidants						
No. manual sensors						
Frequency of manual Sensor visits	per week	per week	per week	per week	per week	per week
Servicing						
No. station operators						
Avg. mi/day traveled by operators visiting stations						

TABLE 1. (continued)

2. Obtain station information: (a) avg. sq. ft. per station _____; (b) maintenance of log book at _____% of stations.
3. Obtain the network's descriptive sheet for each site, or obtain information giving: (a) height of probes or intakes and biasing sources, (b) % of time access to instruments is physically unavailable _____.
4. Determine whether there were any acts of thefts or vandalism at sites. If so, list the amount of loss in the past year; per AQCR: (1) $_____, (2) $ _____, (3) $ _____, (4) $_____, (5) $_____, (6) $_____.
5. List the percentage of data lost per AQCR in the past year, due to station inaccessibility (weather, traffic, etc.):
   (1) _____, (2) _____, (3) _____, (4) _____, (5) _____, (6) _____.
6. List the down times per AQCR in the past year of all sensors:
   (1) _____, (2) _____, (3) _____, (4) _____, (5) _____, (6) _____.

D. NETWORK INFORMATION

1. Obtain a map of the area (from Local or Regional Planning Agency).
2. Locate Air Monitoring Sites on the map and indicate the number of sensors and pollutants monitored at each.
3. Does the network utilize data in developing an air model _____, in trend prediction _____, in air quality evaluation _____?
4. Is an air quality report published for public release annually _____? Is air quality information released daily to news media _____?
5. Are data summaries prepared monthly _____, quarterly _____? How soon after the period ends are they released _____?
6. Obtain pollutant isopleth maps of the network area, if available.

TABLE 1. (continued)

E. FACILITIES AND EQUIPMENT INFORMATION. (Fill in all blanks)

1. Are library facilities available? _____.
2. What is the percentage of office personnel with at least 50 sq. ft. per person? _____%
3. What percentage of office utilities are available when needed? _____%
4. What percentage of office supplies are available when needed? _____%
5. What percentage of transportation is available when needed? _____%
6. The following information is needed on the wet (sample analysis) laboratory, whether maintained by the network, or whether an outside facility:

   a. What is the percentage of laboratory personnel with at least 100 sq. ft./analyst? _____%
   b. Are there check list controls on cleanliness? _____ On ambient conditions? _____ On electrical service? _____.
   c. What percentage of the time are standard procedures followed in labeling and storing chemicals and reagents? _____%
   d. What percentage of the time are standard procedures followed in labeling and storing standard solution bottles? _____%
   e. What percentage of chemical and gas standards are validated and documented? _____%
   f. Is associated equipment (cuvettes, volumetric ware, dilutors, consumables, refrigeration, etc.) sufficient? _____
   g. What percentage of the time is standard cleaning of associated equipment used? _____%
   h. Is supply inventory maintained? _____
   i. Is quality of purchases checked? _____
   j. List specifications as indicated for the following laboratory instruments used for analysis, the calibration frequency of the instruments, manufacturers (mfr.) recommendations, and documentation of calibration:

Instrument	Sensitivity/Precision	Calib. Freq. Mfr. Recom./Actual	% of Documentation
Analytical Balance	mg. Weighing chamber _____ x _____ in.		
Spectrophotometer	Eff.band width _____		
Conductivity meter	X		
pH meter	X		
Atomic absorption spectrophotometer	X		

   k. Are documented results used to modify calibration frequency? _____
   l. _____% of calibration techniques are approved methods, i.e., those listed in the Federal Register (FR, 40 CFR 53, 1975).

TABLE 1. (continued)

7. The following information is needed on laboratory measurements:

   a. _____% of the analyses use approved techniques (listed in the Federal Register, Sections 50 and 55).
   b. _____% of the time statistical control chart techniques are used.
   c. Is there scheduled participation in interlaboratory testing _____?
   d. Are spiked samples _____ or standard reference materials _____ used to validate data?
   e. _____% of samples undergo replicate analysis?

8. The following information is needed on sensor calibration/maintenance equipment and procedures:

   a. List equipment used to calibrate sensors for each pollutant, specs (as in 6.j. above) source of calibration methods used, Mfr. recommendations on calibration frequency, actual frequency of sensor calibration, whether calibration is documented, and whether documentation is used to modify the schedule:

Sensor for	Calib. Equip.	Equip. Specs.	Method Source	Mfr. Freq.	Actual Freq.	Documentation	Use
TSP							
SO_2							
NO_2							
CO							
Photo-chemical oxidants							

   b. Check on availability of associated equipment: volumetric ware _____, still _____, thermometer _____, barometer _____, manometer _____, other.
   c. Are secondary standards documented and validated on a schedule? _____
   d. The following information is needed on sensor maintenance: Maintenance of each sensor is on a schedule and documented _____% of the time; compared with Mfr. recommendations _____% of the time; documentation is used to modify schedules _____% of the time; _____% of maintenance techniques are approved; preventative maintenance is also documented _____.

9. Statistical control chart techniques are used in analysis of field data _____% of the time.

TABLE 1. (continued)

	AQCR 1	AQCR 2	AQCR 3	AQCR 4	AQCR 5	AQCR 6
10. a) Check if mobile unit is available						
b) List the performance specs, Mfr, and Model of each automatic sensor, as available	SO_2 Oxidants CO Mfr Mod Mfr Mod Mfr Mod	SO_2 Oxidants CO Mfr Mod Mfr Mod Mfr Mod	SO_2 Oxidants CO Mfr Mod Mfr Mod Mfr Mod	SO_2 Oxidants CO Mfr Mod Mfr Mod Mfr Mod	SO_2 Oxidants CO Mfr Mod Mfr Mod Mfr Mod	SO_2 Oxidants CO Mfr Mod Mfr Mod Mfr Mod
Parameter Units						
(1) Range ppm						
(2) Noise ppm						
(3) Lower Detectable Limit ppm						
(4) a. Each Interferent Equivalent ppm						
b. Total Interferent ppm						
(5) Zero drift, 12 and 24 hours ppm						
(6) Span drift, 24 hrs 20% of upper range limit %						
80% of upper range limit %						
(7) Lag Time min						
(8) Rise Time min						
(9) Fall Time min						
(10) Precision 20% of upper range limit %						
80% of upper range limit %						

TABLE 1. (continued)

c) List the following for each manual sensor used:	AQCR 1						AQCR 2						AQCR 3					
	SO_2		NO_2		TSP		SO_2		NO_2		TSP		SO_2		NO_2		TSP	
Characteristic Units	Mfr	Mod	Mfr	Mod	Mfr	Mod	Mfr	Mod	Mfr	Mod	Mfr	Mod	Mfr	Mod	Mfr	Mod	Mfr	Mod
(1) Pump maintains air pressure differential at desired flow rate of _____ atmospheres					X						X						X	
(2) 24-hour flow rate _____ liters/min					X						X						X	
(3) Air flow measured by calibrated rotameter precision: ± _____ %					X						X						X	
(4) Flow rate of air through a 8 by 10 in. filter _____ ft^3/min	X	X					X	X					X	X				

c) List the following for each manual sensor used:	AQCR 4						AQCR 5						AQCR 6					
	SO_2		NO_2		TSP		SO_2		NO_2		TSP		SO_2		NO_2		TSP	
Characteristic Units	Mfr	Mod	Mfr	Mod	Mfr	Mod	Mfr	Mod	Mfr	Mod	Mfr	Mod	Mfr	Mod	Mfr	Mod	Mfr	Mod
(1) Pump maintains air pressure differential at desired flow rate of _____ atmospheres						X						X						X
(2) 24-hour flow rate _____ liters/min						X						X						X
(3) Air flow measured by calibrated rotameter precision: ± _____ %						X						X						X
(4) Flow rate of air through a 8 by 10 in. filter _____ ft^3/min	X	X					X	X					X	X				

TABLE 2. TECHNICAL SERVICES PERSONNEL INFORMATION*

1. Positions and section†	2. Qualifications required♦ (degree/exp.)	3. Incumbents' qualifications (degree/exp.)	4. Years in present position	5. Starting position (if other than present)	6. Salary of starting position today	7. Salary today	8. Years with network	9. On-job training availability
Administration								
Air Monitoring								
Lab & Data Anal.								

* Use additional pages, as necessary.

† Section = Administrative, Air Monitoring (Station operators, engineers, technicians), Lab and Data Analysis.

♦ Stated in U.S. EPA, 1972.

SECTION II

EVALUATION OF NETWORK PLAN AND DESIGN

II.A RATING FOR NUMBER OF MONITORING SITES

EPA Guidelines provide several possible methods for determining the number of monitoring sites needed for an AQCR. The basic method (F.R., 40 CFR 51.17, 1971, amended 1975a) determines the minimum required number of sites by AQCR classification and population class. Additional "possible methods for determining a more adequate number of stations for an AQCR. . .based on varying levels of information" are given in an Appendix to U.S. EPA, 1974. Part A of this Section provides three of these methods, based on varying levels of information, and incorporates the concept of air quality indicators for determining the number of sites needed. The first method deals with the number of sites for TSP and SO_2. The second method deals with the number of sites for CO, photochemical oxidants and NO_2; and the last method concerns the number of sites for all five pollutants. If sufficient information is available, use all three methodologies that are presented in II.A.1, II.A.2, and II.A.3, and calculate or determine a value for N_r (number recommended) by each method.

II.A.1 A Method to Determine the Number of SO_2 and TSP Sites, Using Pollutant Isopleth Maps (in terms of annual averages). (If such maps are not available, go to Section II.A.2.)

This guideline method (U.S. EPA, 1974; U.S. EPA, 1972) estimates the number of stations needed as a function of both the land area of the region and the pollutant concentrations. Each AQCR is divided into three distinct zones, on the basis of annual average iso-concentration lines representing the ambient air quality standard and the background values appropriate for the region. The three zones, for which the land areas are determined from the isopleth map, are:

- X = area in square kilometers (km^2) where concentrations are higher than ambient air quality standard.
- Y = area (km^2) where concentrations are above background, but less than ambient standards.
- Z = area (km^2) where existing concentrations are at background levels.

The number of samplers for each zone, N_X, N_Y, N_Z, of each AQCR in the network is calculated separately for SO_2 and TSP, using the following equations from EPA guidelines (U.S. EPA, 1974; U.S. EPA, 1972):

$$N_x = 0.0965 \frac{C_m - C_s}{C_s} \quad X \tag{1}$$

$$N_y = 0.0096 \frac{C_s - C_b}{C_s} \quad Y \tag{2}$$

$$N_z = 0.0004 \; Z \tag{3}$$

where C_m = value of maximum pollutant isopleth, with a contour interval of 10 micrograms per cubic meter ($\mu g/m^3$) as indicated on isopleth map.

C_s = ambient air quality standard in $\mu g/m^3$ annual average.

C_b = value of minimum pollutant isopleth, with a contour interval of 10 $\mu g/m^3$ annual average as indicated on isopleth map.

Then N_r, the total number of samplers in each AQCR for each of the two pollutants, is obtained by summing the estimated numbers in each zone:

$$N_r(SO_2) = (N_x + N_y + N_z) \text{ for } SO_2 \tag{4}$$

$$N_r(TSP) = (N_x + N_y + N_z) \text{ for TSP} \tag{5}$$

The calculations are accomplished by carrying out the following two steps.

Step 1

From the isopleth map of the network, determine for each AQCR in the network the basic values of X, Y, Z, C_m, C_s, and C_b for SO_2 and TSP and place these values in Table 3.

TABLE 3. ZONE AREAS AND POLLUTANT CONCENTRATIONS

	AQCR					
	(1)	(2)	(3)	(4)	(5)	(6)
SO_2 Data						
X						
Y						
Z						
C_m						
C_s						
C_b						
TSP Data						
X						
Y						
Z						
C_m						
C_s						
C_b						

Step 2

Calculate N_x, N_y, and N_z, the number of sites needed in each zone of each AQCR, to monitor SO_2 and TSP. Substitute values from Table 3 (p. 13) into Eqs. (1), (2), and (3) on page 12. Record these values in Table 4. Then calculate the values of N_r for SO_2 and TSP in each AQCR by substituting the N_x, N_y, and N_z values into Eqs. (4) and (5) on p. 12. Record the values of N_r in Table 4.

TABLE 4. NUMBER OF MONITORING SITES FOR SO_2 AND TSP

	AQCR					
	(1)	(2)	(3)	(4)	(5)	(6)
For SO_2						
N_x						
N_y						
N_z						
N_r						
For TSP						
N_x						
N_y						
N_z						
N_r						

II.A.2 A Method To Determine the Minimum Required Number of Sites*

This method, given in both U.S. EPA 1974 and 1972, determines the minimum number of sites for all five major pollutants, based on concentration levels and population size. If you completed Section II.A.1, follow the procedures of this section only for CO, photochemical oxidants, and NO_2. Table 5, on pp. 16 and 17, combines and reproduces material contained in both the EPA Guidelines noted. This material includes the Criterial Concentrations of each of the five pollutants, the Minimum Number of Monitoring Sites, as a function of regional classification and population, and the Minimum Frequency of Monitoring.

Step 1

In Table 6 (p. 18), record the population of each AQCR and the Priority Classification for each of the pollutants in each AQCR of the network (from information in part C of Table 1).

Step 2

Fill in the value of N_r in Table 6 for each of the five pollutants in each AQCR, where

N_r = Minimum number of air monitoring sites, according to Table 5.

*Source: CFR Title 40, Part 51, 1971, amended 1975a.

TABLE 5. MINIMUM NUMBER OF AIR QUALITY MONITORING SITES AS A FUNCTION OF CONCENTRATION LEVELS AND POPULATION

Criteria[a] concentrations	Regional classification	Pollutant	Measurement method	Region population	Minimum number of air quality monitoring sites[a]	Minimum frequency of sampling
24-hr Max: >325 $\mu g/m^3$ Annual Geom. Mean: >100 $\mu g/m^3$	1	Suspended particulates	High-volume sampler	Less than 100,000	4	One 24-hour sample every 6 days[c]
				100,000-1,000,000	4 + 0.6 per 100,000[b]	
				1,000,000-5,000,000	7.5 + 0.25 per 100,000[b]	
				Above 5,000,000	12 + 0.16 per 100,000	
			Tape sampler	--	One per 250,000[b] up to 5 sites	One sample every 2 hours
24-hr Max: >455 $\mu g/m^3$ (.17) Annual Arith. Mean: >100 $\mu g/m^3$ (.04)		Sulfur dioxide	Pararosaniline or equivalent[d]	Less than 100,000	2	One 24-hour sample every 6 days (gas bubbler)[c] Continuous
				100,000-1,000,000	2.5 + 0.5 per 100,000[b]	
				1,000,000-5,000,000	6 + 0.15 per 100,000[b]	
				Above 5,000,000	11 + 0.05 per 100,000[b]	
				Less than 100,000	1	
				100,000-5,000,000	1 + 0.15 per 100,000[b]	
				Above 5,000,000	6 + 0.05 per 100,000[b]	
8-hr Max: >14 mg/m^3 (12) 1-hr Max: >55 mg/m^3 (48)		Carbon monoxide	Nondispersive infrared or equivalent[e]	Less than 100,000	1	Continuous
				100,000-5,000,000	1 + 0.15 per 100,000[b]	
				Above 5,000,000	6 + 0.05 per 100,000[b]	
1-hr Max: $\geq$195 $\mu g/m^3$ (.10)		Photochemical oxidants	Gas phase chemiluminescence or equivalent[f]	Less than 100,000	1	Continuous
				100,000-5,000,000	1 + 0.15 per 100,000[b]	
				Above 5,000,000	6 + 0.05 per 100,000[b]	
Annual Arith. Mean: >110 $\mu g/m^3$ (0.6)		Nitrogen dioxide	24-hour sampling method (Jacobs-Hochheiser method)[i]	Less than 100,000	3	One 24-hour sample every 14 days (gas bubbler)[g]
				100,000-5,000,000	4 + 0.6 per 100,000[b]	
				Above 10,000,000	10	

TABLE 5. (continued)

Criteria[a] concentrations	Regional classification	Pollutant	Measurement method	Region population	Minimum number of air quality monitoring sites[a]	Minimum frequency of sampling
24-hr Max: 150-325 $\mu g/m^3$	II	Total suspended particulates	High-volume sampler	--	3	One 24-hour sample every 6 days[c]
Annual Geom. Mean: 60-95 $\mu g/m^3$			Tape sampler	--	1	One sample every 7 hours
24-hr Max: 260-455 $\mu g/m^3$ (.10-.17)		Sulfur dioxide	Pararosaniline	--	3	One 24-hour sample every 6 days (gas bubbler)[c]
Annual Arith. Mean: 60-100 $\mu g/m^3$ (.02-.04)				--	1	Continuous
24-hr Max: >150 $\mu g/m^3$	III[h]	Total suspended particulates	High-volume sampler	--	1	One 24-hour sample every 6 days[c]
Annual Geom. Mean: >60 $\mu g/m^3$				--		
24-hr Max: >260 $\mu g/m^3$ (.10)		Sulfur dioxide	Pararosaniline	--	1	One 24-hour sample every 6 days (gas bubbler)[c]
Annual Arith. Mean: >60 $\mu g/m^3$ (.02)						

* ( ) = ppm (parts per million)

a In interstate regions, the number of sites required should be prorated to each state on a population basis.

b Total population of a region. When required number of samplers includes a fraction, round off to nearest whole number.

c Equivalent to 61 random samples per year.

d Equivalent methods are: (1) Gas Chromatographic Separation-Flame Photometric Detection (provided Teflon is used throughout the instrument system in parts exposed to the air stream); (2) Flame Photometric Detection provided interfering sulfur compounds present in significant quantities are removed); (3) Coulometric Detection (provided oxidizing and reducing interferences such as O_3, NO_2, and H_2S are removed); and (4) the automated Pararosaniline Procedure.

e Equivalent method is Gas Chromatographic Separation - Catalytic Conversion - Flame Ionization Detection.

f Equivalent methods are: (1) Potassium Iodide Colorimetric Detection provided a correction is made for SO_2 and NO_2); (2) UV Photometric Detection of Ozone (provided compensation is made for interfering substances); and (3) Chemiluminescence Methods differing from that of the reference method.

g Equivalent to 26 random samples per year.

h It is assumed that Federal Motor Vehicle emission standards will achieve and maintain the national standards for CO, NO_2, and photochemical oxidants; therefore no monitoring sites are required for these pollutants.

i The Jacobs-Hochheiser method is no longer the EPA-approved technique, even though it is listed in the table. EPA is currently evaluating three measurements and will publish a new reference method for NO_2.

NOTE: Criterial Concentrations are reproduced from U.S. EPA, 1972. The rest of Table 5 is reproduced from F.R., 40 CFR 51, 1971, Amended 1975a.

TABLE 6. REQUIRED MINIMUM NUMBER OF MONITORING SITES BASED ON AQCR CLASSIFICATION AND POPULATION

	AQCR											
	(1) Population		(2) Population		(3) Population		(4) Population		(5) Population		(6) Population	
	Priority class.	N_r	Priority class.	N_r	Priority class.	N_r	Priority class.	N_r	Priority class.	N_r	Priority class.	N_r
TSP												
Hi-Vol	X		X		X		X		X		X	
Tape												
SO_2												
Intermittent	X		X		X		X		X		X	
Continuous												
CO												
OX												
NO_2												

II.A.3 A Method to Determine an "Adequate" Number of Sites for Photochemical Oxidants and NO_2

This method, from U.S. EPA 1974, determines the number of sites as a function of topography and climatology. Table 7 (p. 20) reproduces the descriptions of four Topography regimes and the factor, T_F, associated with each; and the eleven Climatology regimes and the associated short-term and long-term factors, C_F, for photochemical oxidants and NO_2.

Step 1

From Table 7, determine the Topography regime and associated factor, T_F, and the Climatology regime and associated factor, C_F, for photochemical oxidants and NO_2 for each AQCR in the network. List the values in the first two lines of Table 8.

Step 2

Calculate the value of N_r, the "adequate" number of monitoring sites for photochemical oxidants and NO_2 as a function of topography and climatology in each AQCR, and list the values in the bottom line of Table 8. Calculate the values by using Eq. (6), provided in U.S. EPA, 1974.

$$N_r = T_F \times C_F \times M_P \qquad (6)$$

where values of T_F and C_F are those recorded in Table 8, and

M_P = "minimum" number of sites for photochemical oxidants and NO_2 recorded in Table 6 (p. 18).

TABLE 7. TOPOGRAPHY AND CLIMATOLOGY

Topography* regime		Factor (T_F)	Climatology regime	Short-term factor oxidants (C_F)	Long-term factor NO_2 (C_F)
Valley-ridge	Continuous contours of greater than 300 feet between a valley and a ridge within a mile of the horizontal distance	1.8	California-Oregon Coastal	2.0	1.6
			Washington Coastal	1.4	1.4
			Rocky Mountain	2.0	1.1
			Great Plains	1.0	1.0
			Great Lakes-Northeast	1.1	1.4
Hilly-mountainous	Terrain elevations greater than 800-1,000 feet between hills or mountains and valley floor	1.5	Appalachian	1.6	1.4
			Mid-Atlantic Coastal	1.4	1.0
			South Florida	1.0	1.0
			Tropical	1.0	1.0
Shoreline	Bodies of water of a size at least equal to the Great Salt Lake	1.2	South Coastal Alaska	1.5	1.5
			North and Central Alaska	2.0	1.8
Level or gently rolling	No marked contours or shorelines	1.0			

* It may be necessary to subdivide the AQCR if the topographic features are significantly variable, and to calculate each area separately.

Source: U.S. EPA, 1974.

TABLE 8. DETERMINATION OF THE NUMBER OF SITES FOR PHOTOCHEMICAL OXIDANTS AND NO_2

	AQCR											
Factors	(1)		(2)		(3)		(4)		(5)		(6)	
	OX	NO_2	OX	NO_2	OX	NO_2	OX	NO_2	OX	NO_2	OX	NO_2
T_F												
C_F												
N_r												

II.A.4 Method for Rating the Number of Sites per Pollutant in the Network

The results calculated in the previous three EPA Guidelines methods for determining the number of sites per pollutant are compared with the actual number of sites, and a rating is derived for each. These ratings are then weighted with respect to each pollutant Priority Classification, to provide a rating of the number of sites per pollutant, for each AQCR. Whether any particular pollutant requires additional sites is indicated, if the rating is significantly less than 1. The network rating is also determined.

Step 1

In Table 9 (p. 23), fill in the value of N_a, the actual number of existing monitoring sites (from Table 1) for each pollutant monitored in each AQCR. Then, from Tables 3 (p. 13), 6 (p. 18), and 8 (p. 21), fill in the largest value of N_r calculated for each pollutant monitored in each AQCR. Use the sums of the intermittent and continuous stations for TSP and SO_2 in Table 6 for the values for N_r for TSP and SO_2.

Step 2

Fill in the columns labeled % in Table 9, where $\% = N_a/N_r \times 100$.

Step 3

Use Figure 1 (p. 23) to determine the R value for each pollutant of each AQCR, and list these values in Table 10 (p. 25) under the values of R_1 for AQCR number 1, R_2 for AQCR number 2, etc. Determine each R by locating on the horizontal axis of Figure 1 each percent value for each pollutant (from Table 9). Then locate the percent value on the curve and read the corresponding value of R on the vertical axis.

Step 4

Use the Priority Classifications listed in Table 6 (p. 18) for each pollutant in each AQCR to determine whether case a, b, c, or d (defined below) most closely matches conditions in each AQCR, thus defining the air quality indicators (Priority I pollutants) where:

Case a: Priority I for TSP and SO_2; Priority II and/or III for the other major pollutants.

Case b: Priority I for photochemical oxidants and/or CO; Priority II and/or III for the other major pollutants.

Case c: Priority I for any pollutant mix other than case a or case b.

Case d: Priority II and/or III for all major pollutants.

TABLE 9. ACTUAL VS RECOMMENDED NUMBERS OF SITES

	AQCR																	
	(1)			(2)			(3)			(4)			(5)			(6)		
	N_a	N_r	%	N_a	N_r	%	N_a	N_r	%	N_a	N_r	%	N_a	N_r	%	N_a	N_r	%
TSP																		
SO_2																		
CO																		
OX																		
NO_2																		

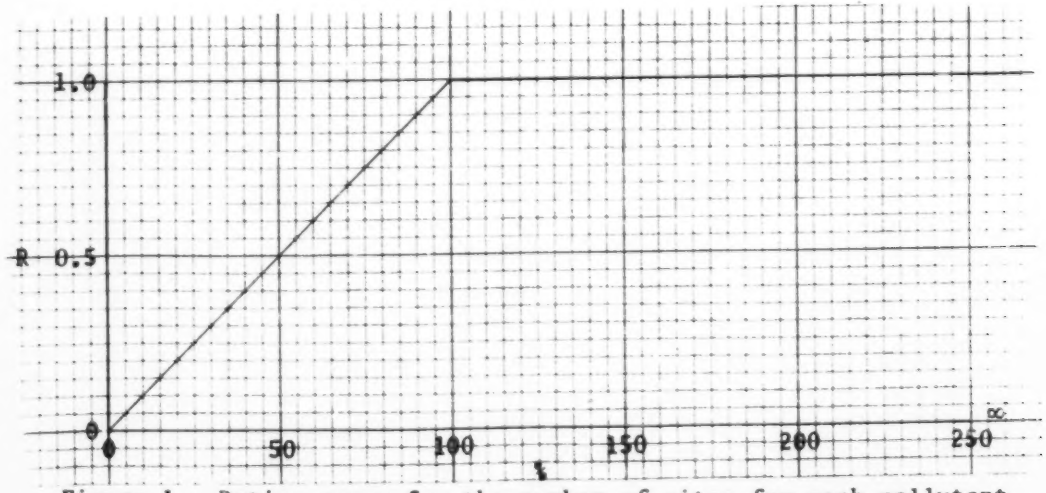


Figure 1. Rating curve for the number of sites for each pollutant

List the case alongside each AQCR number in Table 10. Then list for each AQCR the M values given in Table 11 corresponding to each case of pollutant mix.

Step 5

Multiply each R_i value by its M value and put the product in the column labeled E for each AQCR.

Step 6

On the bottom line of Table 10, labeled AQCR R, record the sums of the E's for each AQCR. The maximum possible value for each AQCR R is 1, which corresponds to a perfect rating for total number of sites.

Step 7

At the right on the same bottom line, in the column labeled "Sum R," place the sum of the AQCR R's. Then divide by the number of AQCRs in the network, and place that answer on the bottom line of the column labeled "Avg. R." This final value represents the overall network Rating on total number of fixed monitoring sites. A value of 1 would represent a perfect score.

TABLE 10. RATING OF THE NUMBER OF SITES PER POLLUTANT

	AQCR													
	(1) Case - $R_1 \times M_1 = E_1$		(2) Case - $R_2 \times M_2 = E_2$		(3) Case - $R_3 \times M_3 = E_3$		(4) Case - $R_4 \times M_4 = E_4$		(5) Case - $R_5 \times M_5 = E_5$		(6) Case - $R_6 \times M_6 = E_6$		SUM R	AVG. R
TSP														
SO_2														
CO														
OX														
NO_2														
AQCR R														

TABLE 11. MULTIPLYING FACTORS FOR FOUR CASES OF AIR POLLUTION

	Case a M	Case b M	Case c M	Case d M
TSP	0.227	0.180	0.223	0.210
SO_2	0.216	0.180	0.214	0.208
CO	0.193	0.201	0.199	0.203
OX	0.182	0.252	0.196	0.208
NO_2	0.182	0.187	0.168	0.171

Case a: Priority I for TSP, SO_2

Case b: Priority I for Oxidants and/or CO

Case c: Priority I for any Pollutant Mix other than Case a or Case b

Case d: Only Priority II or III for all five major pollutants

II.B. RATING OF SITE DISTRIBUTION

Site distribution will be evaluated with respect to two major factors: site descriptions and air quality indicators. The site descriptors are:

Source-Oriented Sites, which encompass central city urban industrial locations, and other major pollutant sources,

Population-Oriented Sites, which encompass residential and suburban locations, including shopping areas,

Rural Sites, which provide background data.

Pollutant conditions are defined by cases a, b, c, and d, described in Section II.A.4. In this evaluation, the numbers of intermittent and continuous sensors are not specified. The requisite number and distribution of sites as functions of pollutants monitored are considered more important. Only general areas for sites are indicated. Precise locations are not identifiable for many reasons, such as availability and budgetary constraints, as well as involving analysis of micro-meteorology and emissions distribution, which are not within the scope of this manual.

II.B.1 Method of Rating

The evaluational technique is presented in the following steps. Use Table 12 for a work sheet.

Step 1

Fill in the heading of Table 12 (p. 29), as you did for Table 10 (p. 25), with the case (a, b, c, or d) that most nearly matches conditions in each AQCR.

Step 2

Mark the major areas of industrial source emissions for each AQCR on the network area map on which the sites are located. List the total number of sites in each AQCR in Table 12 in the space labeled "No. sites" under each AQCR number. In the rows labeled N_a for each AQCR, list the number of existing sites that are source-oriented, the number that are population-oriented, and the number that are rural, corresponding to the definitions in Section II.A.4.

Step 3

Use Figures 2, 3, 4, and 5 (pp. 27, 28), which provide recommended station distributions for pollution cases a, b, c, and d, respectively, to determine the recommended number of sites of each type for each AQCR. List the recommended values from these figures in the N_r rows of Table 12.

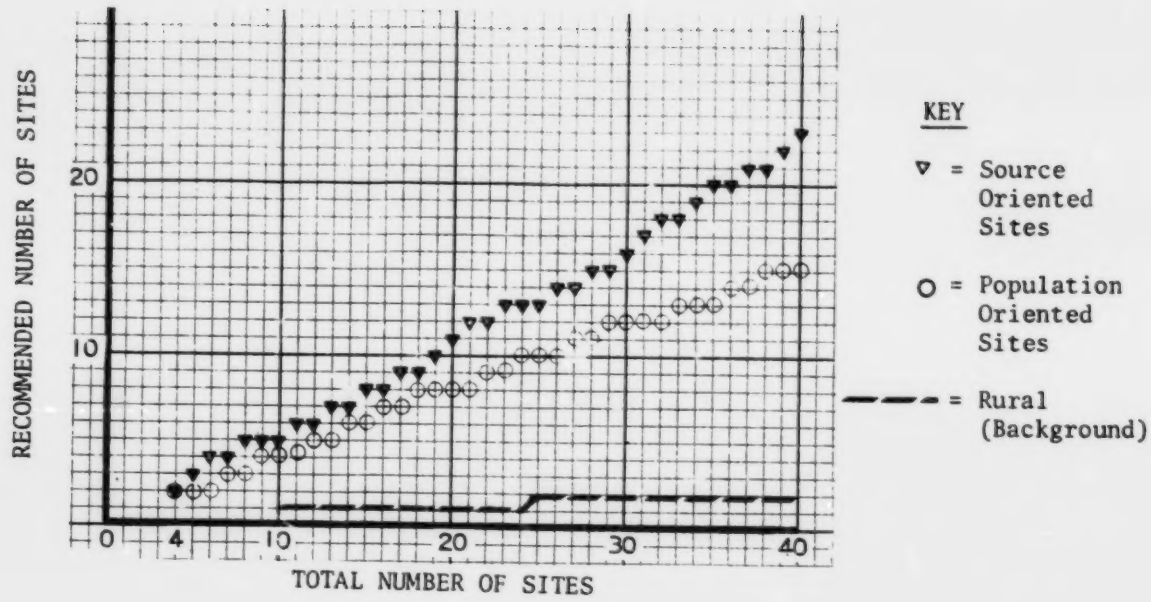


Figure 2. Case a. Priority I for TSP and SO_2

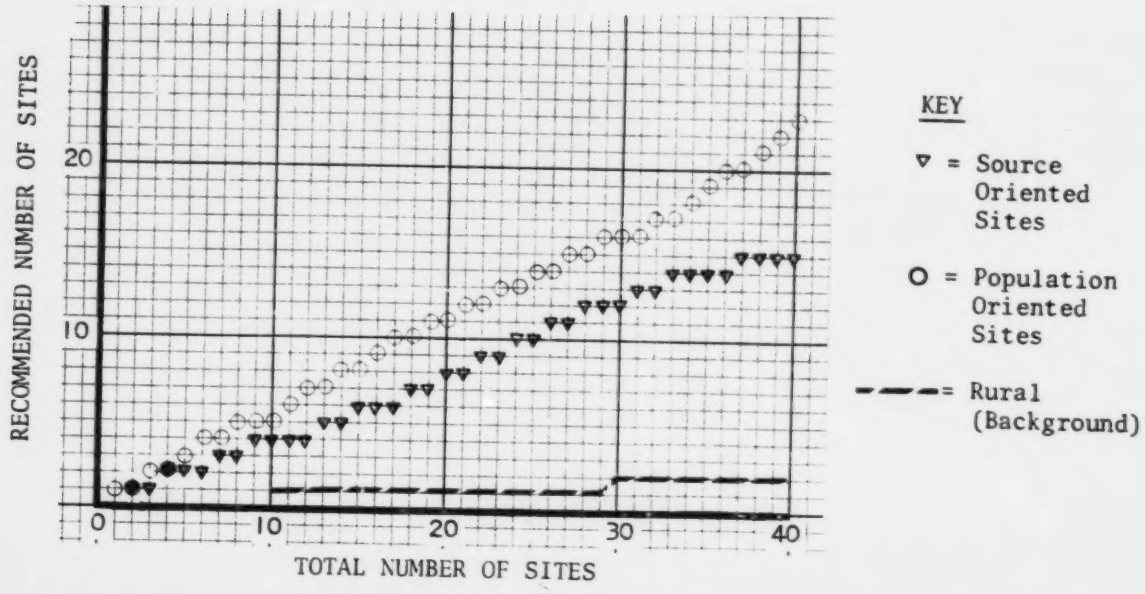


Figure 3. Case b. Priority I for Oxidants and/or CO

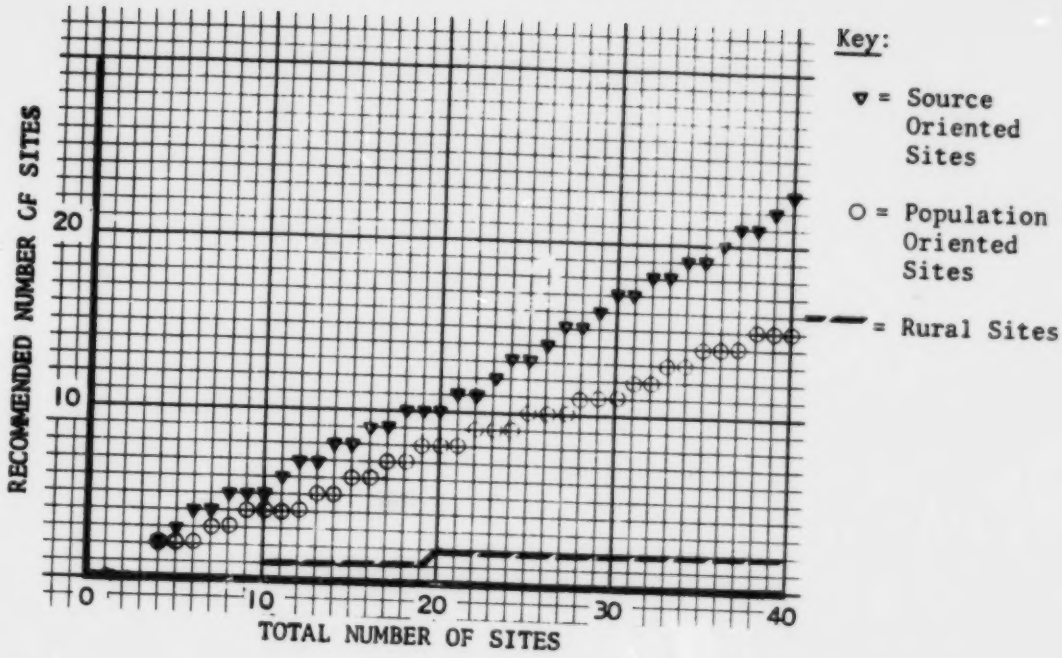
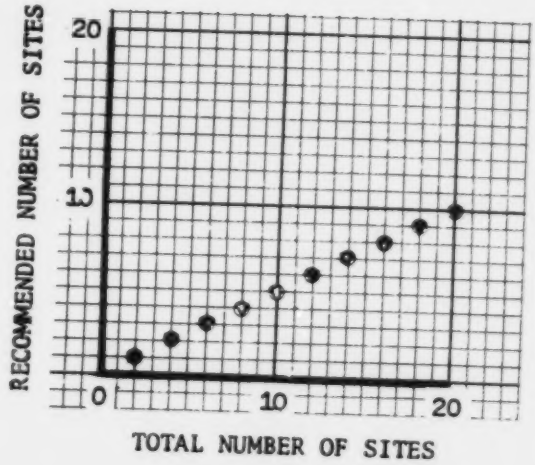


Figure 4. Case c. Priority I for pollutant mix other than case a or case b.



Approximately same distribution for both source- and population-oriented sites.

Figure 5. Case d. Priority II and/or III for all five major pollutants.

TABLE 12. STATION DISTRIBUTION WORK SHEET

Site description		AQCR (1) Case No. sites	(2) Case No. sites	(3) Case No. sites	(4) Case No. sites	(5) Case No. sites	(6) Case No. sites
Source-oriented	N_a						
	N_r						
	%						
		$r_=$	$r_=$	$r_=$	$r_=$	$r_=$	$r_=$
Population-oriented	N_a						
	N_r						
	%						
		$r_=$	$r_=$	$r_=$	$r_=$	$r_=$	$r_=$
Rural	N_a						
	N_r						
	%						
		$r_=$	$r_=$	$r_=$	$r_=$	$r_=$	$r_=$
		Sum r_1	Sum r_2	Sum r_3	Sum r_4	Sum r_5	Sum r_6
		Avg. r_1	Avg. r_2	Avg. r_3	Avg. r_4	Avg. r_5	Avg. r_6

Sum Avg. r_i _____

Avg. R _____

_____

Step 4

Calculate and list each percent value in Table 12 (p. 29), where

$$\% = N_a/N_r \times 100$$

Step 5

Fill in values for r for each AQCR. Values for r are determined by locating, on the horizontal axis of Figure 6 the percent values from Table 12 (p. 29) for each site orientation. After locating each percent value on the curve, the corresponding value of r is read on the vertical axis.

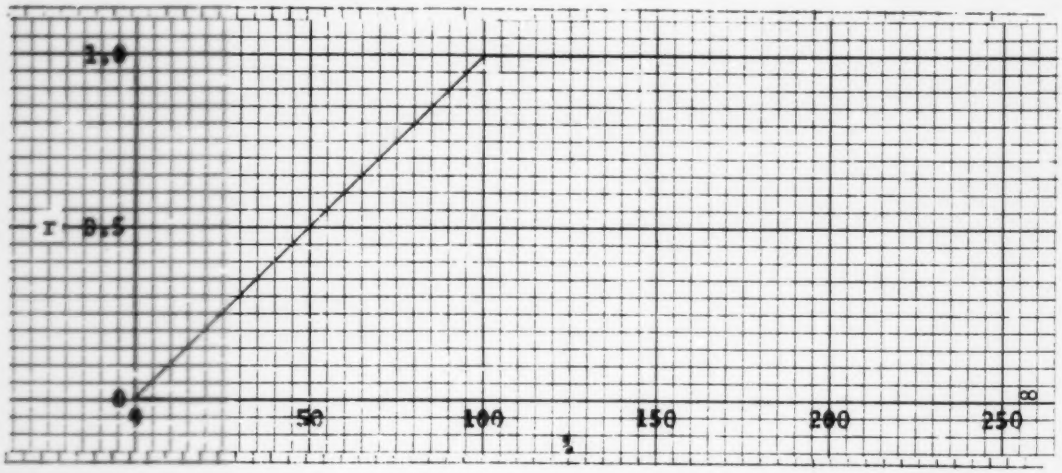


Figure 6. Rating for site distribution in each AQCR

Step 6

Sum the r values for each AQCR and record the sum for each in Table 12.

Step 7

Divide each Sum r by 3 and record each result in the corresponding space for Avg. r. This decimal value, when expressed as a percent, represents the rating of each AQCR for site distribution. The value of 1 represents a perfect rating.

Step 8

Sum the values of all Avg. r's and place that value in the space labeled "Sum Avg. r_i." Then divide the sum by the number of AQCRs and put that result in the space labeled "Avg. R." This decimal value, when expressed as percent, provides the network Rating for site distribution. Comments of Step 7 apply here.

II.C. RATING OF SITE CHARACTERISTICS AND DESIGN

Five site characteristics that affect monitoring efficiency are rated in this subsection. The ratings are then combined to Rate the element. The following paragraph and Table 13 (p. 32) present information for site and intake locations reprinted from U.S. EPA, 1972.

"Avoid sampling locations that are unduly influenced by downwash or by ground dust, such as roof-top air inlet in proximity to a stack, or a ground-level inlet near an unpaved road. In the latter case, either elevate the sampler intake above the level of maximum ground turbulence, or place the sampler intake away from the source of ground dust. Except for stations that sample 1-hour CO concentrations, avoid locations where there are flow restrictions such as buildings, parapets, or trees in the vicinity of the air inlet."

The paragraph above and Table 13 are provided to aid in answering the questions listed under "Procedure Steps," by comparing the Guidelines information with the network site data listed in part C of Table 1. The decimal value used to rate each characteristic was derived from analysis of the Survey Letter responses.

II.C.1 Procedure Steps

Record on the line of the same number in Table 14 (p. 34), the answers to each of the following numbered questions and instructions, for each AQCR in the network.

Step 1

List the percentage, as a decimal fraction, of all intakes free of biasing sources.

Step 2

List the percentage, as a decimal fraction, of all intakes for which air flow is unobstructed.

Step 3

Sum the values for each AQCR.

Step 4

List the average of the sum of the two values.

Step 5

List the product of 0.261 times the average above.

TABLE 13. SAMPLING LOCATION GUIDELINES FOR AREAS OF ESTIMATED MAXIMUM POLLUTANT CONCENTRATION

Pollutant category	Pollutant	Station location	Position of air inlet		
			Height from ground (ft)	Vertical clearance above supporting structure (ft)	Horizontal clearance beyond supporting structure (ft)*
Primary stationary source pollutant	SO_2	Determined from atmospheric diffusion model, historical data, emission density, or other information; should be representative of population exposure.	<50	>3	>5
	NO_2	Same as above.	<50	>3	>5
	Particulates	Same as above.	<50	>3	>3
Primary mobile source pollutant	CO (1-hour averaging time)	Representing area containing dense, slow-moving traffic, obstructions to air flow (tall buildings), and pedestrian population, such as major downtown traffic intersection (<20 ft from street curb).	<15	>3	>3
	CO (8-hour averaging time)	Representing area of high traffic density in residential area, such as major thoroughfare in center city of suburban area (<50 ft from street curb).	<15	>3	>3
Secondary pollutant	OX	Representing residential area downwind of downtown area (5 to 15 miles from downtown and >300 ft from major traffic arteries or parking areas).†	<50	>3	>5
	NO_2	Representing residential area downwind of downtown area (<5 miles from downtown).†	<50	>3	>5

* Not applicable where air inlet is located above supporting structure.
† Downwind of prevailing daytime wind direction during the oxidant season.

Source: U.S. EPA, 1972.

Step 6

List the percentage, as a decimal fraction, of all continuous sensors at a uniform height (reported within ± 3 ft).

Step 7

List the percentage, as a decimal fraction of all intermittent sensors at a uniform height (reported within ± 3 ft).

Step 8

Sum the values of lines 7 and 8 for each AQCR.

Step 9

List the average of the sum of line 8.

Step 10

List the product of 0.225 times the average of line 9.

Step 11

List the percentage, as a decimal fraction, of all site facilities physically available to network personnel at all times that access is desired.

Step 12

List the product of 0.186 and the value of line 11.

Step 13

List, as a decimal fraction, the dollar amount lost due to damage, theft, or vandalism (from part C of Table 1), as a percentage of the Technical Services budget (from part A of Table 1).

Step 14

List the value of (1 minus the value of line 13).

Step 15

List the product of 0.178 and the value of line 14.

Step 16

List the percentage of data lost/year because of inaccessibility of the site. (Inaccessibility may be due to weather conditions, traffic conditions, excessive distance of the site from a station operator, etc., part C, Table 1.)

TABLE 14. RATINGS FOR SITE CHARACTERISTICS AND DESIGN

	AQCR					
	(1)	(2)	(3)	(4)	(5)	(6)
Intakes						
1. Bias						
2. Air Flow						
3. Sum (1+2)						
4. Line 3+2						
5. Line 4 x 0.261						
Sensor Height						
6. Continuous						
7. Intermittent						
8. Sum						
9. Line 8+2						
10. Line 9 x 0.225						
Availability						
11. Facilities						
12. Line 11 x 0.186						
Security						
13. Loss						
14. (1 – line 13)						
15. Line 14 x 0.178						
Accessibility						
16. Data Loss						
17. (1 – line 16)						
18. Line 17 x 0.150						
19. AQCR rating						Sum r
						Avg. R

Step 17

List the value of (1 minus the value of line 16).

Step 18

List the product of line 17 and 0.15.

Step 19

List the decimal fraction that is the sum of lines 5, 10, 12, 15, and 18 for each AQCR in the network. This decimal fraction, when expressed as a percent, is the rating of each AQCR for the five site characteristics considered. The value of 1 indicates a perfect rating. Then sum the ratings for each AQCR and place the value in the box labeled "Sum r," and divide by the number of AQCRs to obtain the Avg. R. This Avg. R, when expressed as percent, is the network Rating for this element. The value of 1 is a perfect Rating. If the Rating is 0.75 or less, it is recommended that Site Characteristics be improved.

II.D. EVALUATION OF NETWORK PLANNING AND DESIGN

The separate ratings of each of the three elements that comprise the Area of Plan and Design for the network are now combined to provide an overall evaluation of this area, by means of the following Steps and use of Figure 7. The weightings incorporated into Figure 7 reflect the results of analysis of the Survey Letters.

II.D.1 Procedure Steps

Step 1

Express Avg. R of Table 10 as a percent _____%. This value is R_N, the network Rating on Number of Sites;

Step 2

Express the Avg. R value of Table 12 as a percent _____%. This value is R_D, the network Rating on Site Distribution.

Step 3

Express the Avg. R value of Table 14 as a percent _____%. This value is R_C, the network Rating on Site Characteristics.

Step 4

In the Nomogram of Figure 7 (p. 37), circle the value of R_N on the bar labeled R_N. The value of R_D on the bar labeled R_D, and the value of R_C on the bar labeled R_C.

Step 5

Draw a straight line crossing bar Q connecting the circled values of R_N and R_D.

Step 6

Draw a second straight line between the circled value of R_C and the point on bar Q where the line of Step 5 crosses it.

Step 7

The line of Step 6 crosses bar E_P. The value at that point provides the evaluation of the network for the Area of Plan and Design.

KEY: R_N = Bar for Rating Number of Sites

Q = Reference Bar

R_D = Bar for Rating Site Distribution

R_C = Bar for Rating Site Characteristics

E_P = Bar for Evaluation of Area of Plan and Design

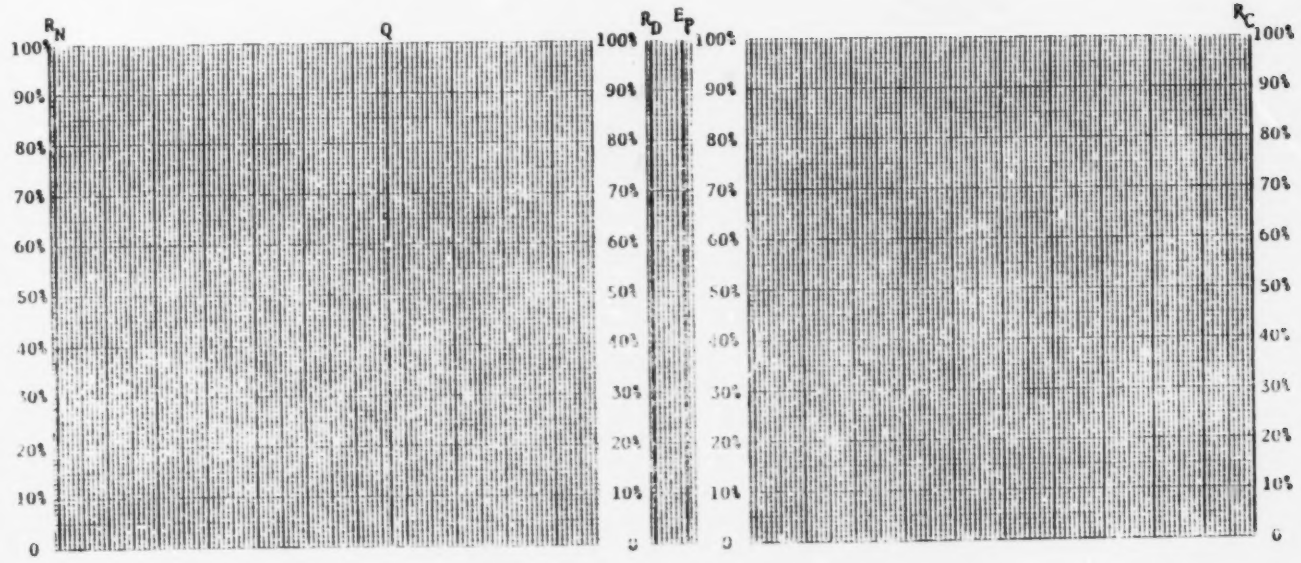


Figure 7. Nomogram for evaluation of network plan and design

SECTION III

EVALUATION OF AREA OF PERSONNEL QUALIFICATIONS

In this Section, the Area of Technical Services Personnel Qualifications is evaluated by rating the Education and Experience of the personnel, and Training opportunities available. The interpretation of training as given in Section III.C includes motivation, to an extent. Table 2 contains the information needed concerning the network personnel and Appendix B of U.S. EPA APTD-1347 (1972) specifies the requirements for each position. Factors used in the ratings and evaluation are derived from the Survey Letter.

III.A EDUCATION RATING

A method follows that rates separately the educational background of personnel in Administration, in Air Monitoring, and in Lab and Data Analysis, and then combines the ratings into one Rating for Technical Services Personnel.

The column numbers reference the numbered columns of Table 2.

III.A.1 Procedure Steps

Step 1

From columns 1 and 2, list the total number of filled Administrative positions requiring a diploma/degree or equivalent experience _____.

Step 2

From column 3, list the number of Administrative personnel meeting only minimum requirements _____.

Step 3

From column 3, determine the number of Administrative personnel with degrees or equivalent experience greater than minimum requirements, and list the result _____.

Step 4

Education Rating for Administrative Personnel:

$$\frac{\text{(Result for Step 2)} + \text{(Result for Step 3)}}{\text{(Result for Step 1)}} = _____.$$

Step 5

From columns 1 and 2, list the total number of filled Air Monitoring (station operators, engineers, and technicians) positions requiring a diploma/degree or equivalent experience _____.

Step 6

From column 3, list the number of Air Monitoring personnel meeting only minimum requirements _____.

Step 7

From column 3, determine the number of Air Monitoring personnel with degrees or equivalent experience greater than minimum requirements, and list the result _____.

Step 8

Education Rating for Air Monitoring Personnel:

$$\frac{\text{(Result for Step 6) + Result for Step 7)}}{\text{(Result for Step 5)}} = \text{_____}.$$

Step 9

From columns 1 and 2, list the total number of filled Lab and Data Analysis positions requiring a diploma/degree or equivalent experience _____.

Step 10

From column 3, list the number of Lab and Data Analysis personnel meeting only minimum requirements _____.

Step 11

From column 3, list the number of Lab and Data Analysis personnel with degrees or equivalent experience greater than minimum requirements and list the result _____.

Step 12

Education Rating for Lab and Data Analysis Personnel:

$$\frac{\text{(Result for Step 10) + (Result for Step 11 x Step 6)}}{\text{(Result for Step 9)}} = \text{_____}.$$

Step 13

Education Rating for Technical Services Personnel: The result of the following calculations provides the Education Rating:

(0.238 x Rating of Step 4) + (0.389 x Rating of Step 8)
+ (0.373 x Rating of Step 12) = R = _____.

If the education of Technical Services Personnel matches the Guidelines requirements, the Rating will be 1.

III.B EXPERIENCE RATING

The following method for Rating the experience of Technical Services Personnel also examines the three groups separately and then combines results in an overall Rating.

The column numbers reference the numbered columns of Table 2.

III.B.1 Procedure Steps

Step 1

Sum the years (in column 4) that all Administrative personnel have been in their present positions, divide by the number of such personnel, and list the result _____.

Step 2

Experience Rating for Administrative Personnel: Use the result of Step 1 and Figure 8 (p. 42), to determine the experience rating for Administrative personnel. Locate the average years in positions on the horizontal axis; then determine and list the rating _____.

Step 3

For Air Monitoring personnel, sum the years (in column 4) that personnel have been in their present positions, divide by the number of such personnel, and list the result _____.

Step 4

Experience Rating for Air Monitoring Personnel: Use the result of Step 3 to determine the experience rating for Air Monitoring personnel from Figure 8 (p. 42). Locate the average years in position on the horizontal axis, determine, and list the rating _____.

Step 5

For Lab and Data Analysis personnel, sum the years (in column 4) that personnel have been in their present positions, divide by the number of such personnel, and list the result _____.

Step 6

Experience Rating for Lab and Data Analysis Personnel: Use the result of Step 5 to determine the experience rating for Lab and Data Analysis personnel from Figure 8 (p. 42). Locate the average years in position and list the rating _____.

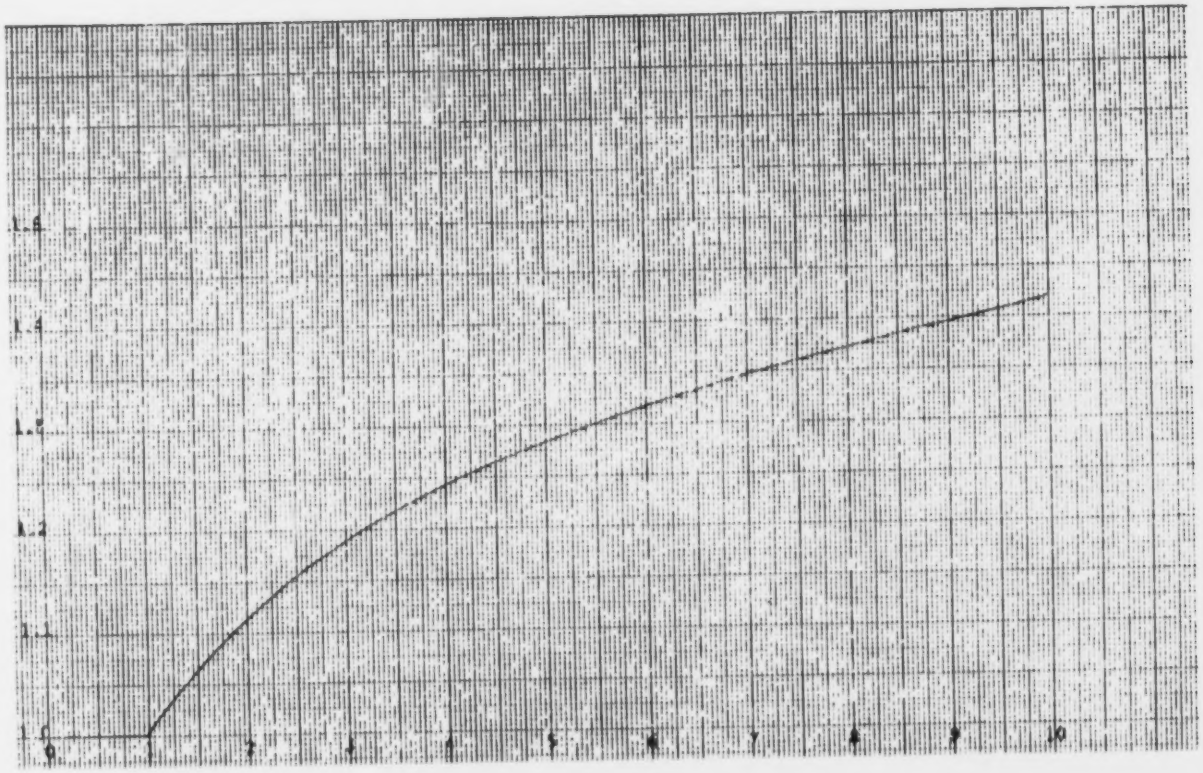


Figure 8. Experience rating curve

Step 7

Experience Rating for Technical Services Personnel:

(0.142 x Rating of Step 2) + (0.232 x Rating of Step 4) +
(0.222 x Rating of Step 6) = R = _____.

A perfect Rating would be a value of 1.

III.C SPECIAL ON-JOB FORMAL TRAINING RATING

"Special On-Job Formal Training" consists of training courses, available to personnel who have been employed by the network for a minimum of one year. Successful completion of a course provides an opportunity for professional development. If the network does not offer such training or make it available to personnel, skip the calculations of this Section, and fill in 0 for the Rating in Step 13. If such training is available, proceed with the following Steps to determine the Rating for training.

This method again examines each group in Technical Services separately, and combines results for ar overall Rating.

The column numbers reference the numbered columns of Table 2.

III.C.1 Procedure Steps

Step 1

List the number of Administrative personnel for whom training programs are available (col. 9) _____.

Step 2

List the total number of Administrative personnel (col. 1) _____.

Step 3

Divide the number listed in Step 1 by the number listed in Step 2 and record the value of f, the fraction of Administrative personnel for whom training is available; f = _____.

Step 4

Rating for Training Available to Administrative Personnel: Use Figure 9 to determine the rating value for training. The result of Section III.B, Step 1 lists the average years of experience in position for Administrative personnel, and four curves are shown in Figure 9 for average years of experience. Select the curve that most closely matches the result of Section III.B, Step 1. Locate on the selected curve the intersection of the value of f (recorded in Step 3, above) that is plotted on the horizontal axis of Figure 9. Determine the value of r on the vertical axis corresponding to the intersection point; r = _____.

Step 5

List the number of Air Monitoring personnel for whom training programs are available (col. 9) _____.

Step 6

List the total number of Air Monitoring personnel (col. 1) _____.

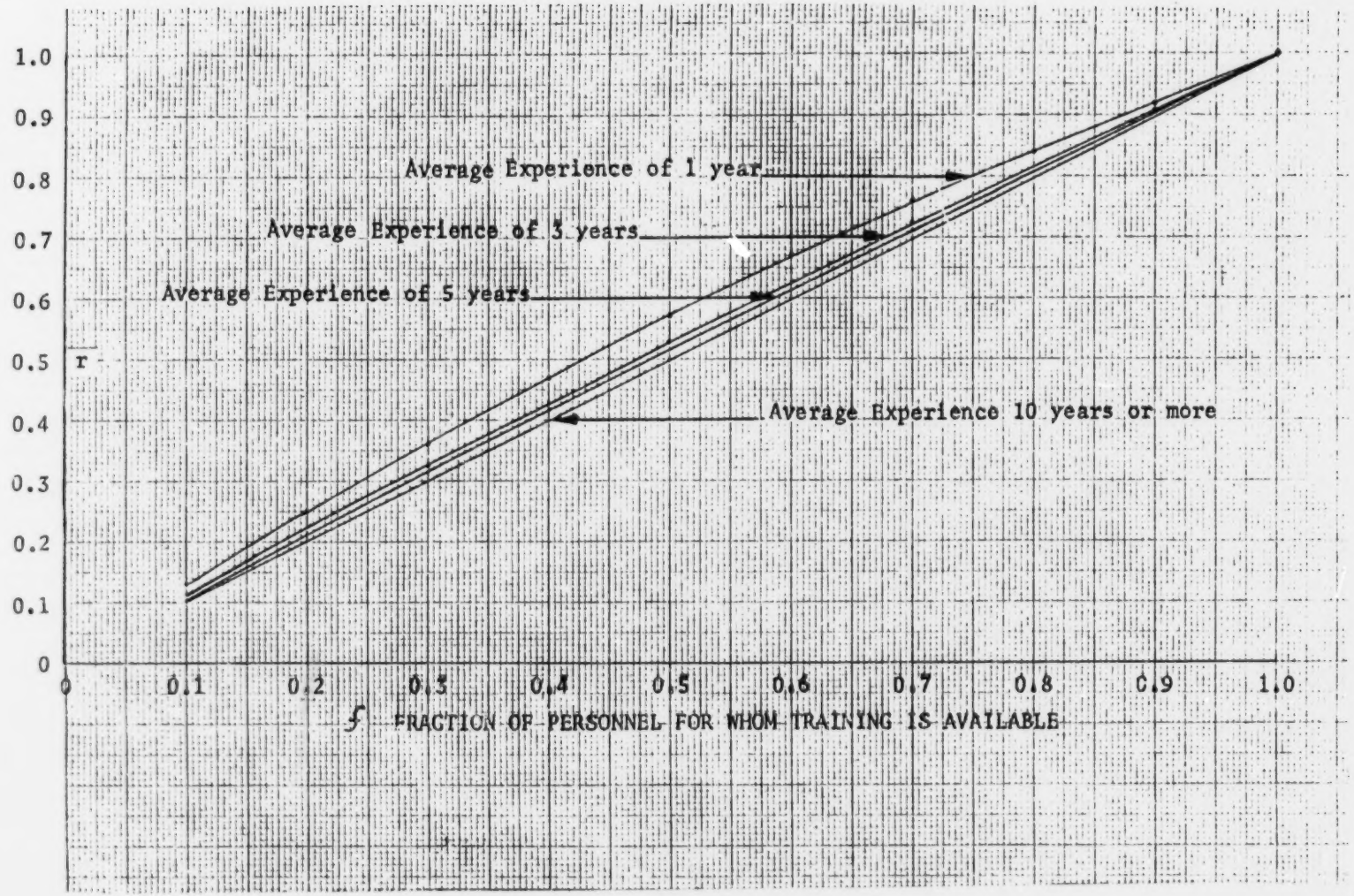


Figure 9. Rating for on-job training program

Step 7

Divide the result of Step 5 by the result of Step 6, and record the value of f, the fraction of Air Monitoring personnel for whom training is available; f = _____.

Step 8

Rating for Training Available to Air Monitoring Personnel: Use the result of Section III.B, Step 3, to determine the appropriate average years experience curve in Figure 9, and use the value of f from Step 7, above, to determine the value of r, as in Step 4, above; r = _____.

Step 9

List the number of Lab and Data Analysis personnel for whom training is available (col. 9) _____.

Step 10

List the total number of Lab and Data Analysis personnel (col. 1) _____.

Step 11

Divide the result of Step 9 by the result of Step 10 and record the value of f, the fraction of Lab and Data Analysis personnel for whom training is available; f = _____.

Step 12

Rating for Training Available to Lab and Data Analysis Personnel: Use the result of Section III.B, Step 5, to determine the appropriate average years experience curve in Figure 9, and the value of f, from Step 11, above, to determine the value of r from Figure 8; r = _____.

Step 13

Training Rating for Technical Services Personnel: The result of the following calculations provides the training Rating:

(0.238 x Result of Step 4) + (0.389 x Result of Step 8) +
(0.373 x Result of Step 12) = R = _____.

III.D EVALUATION OF PERSONNEL QUALIFICATIONS

An evaluation of Personnel Qualifications is provided by the sum of the three products defined below.

Calculate each product as indicated, and sum the results to derive the Area Evaluation.

0.301 x Education Rating of Section III.A, Step 13 = _____.

0.385 x Experience Rating of Section III.B, Step 7 = _____.

0.314 x Training Rating of Section III.C, Step 13 = _____.

Area Evaluation = Sum = _____.

The perfect evaluation would be 1. Values less than 1 suggest need for improvement.

SECTION IV

EVALUATION OF AREA OF FACILITIES AND EQUIPMENT

In this Section, availability and adequacy of the office, laboratory, and field facilities and equipment of an ambient air monitoring network are examined. The overall evaluation is performed only for the equipment and facilities required to monitor the five major pollutants for which specifications are currently available in the Code of Federal Regulations. As specifications are added for other pollutants, additional ratings will be required. The elements of this Section rate separately the equipment needed for wet (sample analysis) laboratories and calibration/maintenance laboratories because some networks do not perform analyses. The weightings used are based on opinions of experts who replied to the Survey Letter. Table 15 is provided to facilitate rating the elements of Office, Wet Lab, and Calibration/Maintenance facilities. Tables 16 and 17 are for rating Field facilities, and Tables 18 and 19 are to aid in the rating of Sensors used in the network. The perfect Rating for any element is a value of 1.

IV.A OFFICE FACILITIES AND EQUIPMENT RATING

The four items rated in this element are listed in Table 15, along with the sections of Table 1 in which the information on them is recorded. Necessary calculations are indicated in the Table, i.e., value x weight = score for each item, and the sum of the scores = R for the element. Convert Table 1 percentage answers to decimal numbers for use as "value."

IV.B RATING OF THE WET LABORATORY

If the network operates a wet laboratory, derive the scores and the Rating indicated in part B of Table 15, where instrument quality is as specified in CFR Title 40, Part 50, 1975b. Calculations are the same as for element A. If analyses are performed on contract, skip part B, and proceed to part C of the Table.

IV.C RATING OF CALIBRATION/MAINTENANCE FACILITIES

Part C of Table 15 provides a Rating of facilities and equipment in the Calibration/Maintenance laboratory. Calculations are again the same as for the preceding two Elements. Calibration equipment available is listed in Table 1, parts 8.a and 8.b. If each instrument or equipment listed in Table 15 is available, the value is 1; if it is not, the value is 0.

TABLE 15. RATINGS FOR OFFICE FACILITIES, WET LABORATORY, CALIBRATION/MAINTENANCE FACILITIES

Each element Rating is the sum of the scores of the items within the element. Each score is the value for the item multiplied by the indicated weight. The column labeled "source" references the section of Table 1 providing information on the item value. When facilities are available, the value is 1; when not available, the value is 0. Convert all percentages to decimal fractions before entering in the value column.

Table 1 source	Item	Value	X	Weight	=	Score	Element rating
	A. Office Facilities & Equipment						
E.1	Library facilities			0.312			
E.2	Personnel space			0.204			
E.3	Office utilities			0.238			
E.4	Office supplies			0.246			
				Sum of scores = R =			_____
	B. Wet Laboratory Evaluation						
	1. Facilities						
E.6.a.	Laboratory space			0.224			
E.6.b.	Laboratory cleanliness			0.227			
E.6.b.	Environmental control			0.248			
E.6.f.	Associated equipment			0.301			
				Sum of scores = R =			_____
	2. Availability of Laboratory Instruments						
E.6.j.	Spectrophotometer			0.240			
	Analytical balance			0.240			
	Conductivity meter			0.190			
	pH meter			0.190			
	Atomic absorption spectrophotometer			0.140			
				Sum of scores = R =			_____

TABLE 15. (continued)

Table 1 source	Item	Value	X	Weight	=	Score	Element rating
	3. Wet Lab Instrument Quality						
E.6.j.	Spectrophotometer value for effective band width: 1 if less than 15 nm 0 if greater than 15 nm			1.000			
	Analytical balance value for sensitivity: 1 if equal to 0.1 mg 0 if greater than 0.1 mg			0.500			
	Value for weighing chamber 1 if sensitivity = 1 and if specific for 8 by 10 in. filter 0 if not			0.500			
				Sum of scores = R =			
	C. Calibration/Maintenance Facilities						
E.7.a.	Spectrophotometer (Specs as in B.3)			0.100			
	Analytical balance (Specs as in B.3)			0.150			
	Permeation tubes			0.100			
	Temperature control equipment			0.050			
	Wet test meter/flow meter			0.150			
	Multimeter or equivalent			0.050			
E.7.b.	Associated equipment (volumetric ware, still, thermometer, barometer, manometer, etc.)			0.300			
				Sum of scores = R =			

IV.D FIELD FACILITIES RATING

In this element, each AQCR of the network is rated separately, since field facilities may vary. Table 16 lists the source section of Table 1 that will provide the information to determine the value for each item, each of the field facilities to be rated, with its symbol, and a space for each AQCR. As in Table 15, convert percentages to decimal fractions before entering them as values. When facilities are available, the value is 1; when they are unavailable, the value is 0, with special instructions for mobile units.

Calculation of the value is straightforward for E, the fraction of stations with environmental control. For S/260, the average station area is compared to 260 sq.ft. (station area specified in U.S. EPA, 1972). T is the fraction of transportation available. The value M_V is determined to be 1 or 0 as follows:

M_V = 1 when (1) M (availability of mobile units) is available and two or more pollutants are classified Priority I

(2) Less than two pollutants are classified Priority I

M_V = 0 when two or more pollutants are classified Priority I and M is unavailable.

M = availability of mobile units.

Table 17 again lists each item to be rated, and the weight for each item that is to be multiplied times the value in Table 16, to derive the score for each item in each AQCR, Note that by summing each row, a network Rating for each item is obtained; summing each column provides a rating for field facilities for each AQCR, and finally, the network Rating for Field Facilities is obtained by summing the Rs for each AQCR and dividing by the number of AQCRs.

TABLE 16. VALUES FOR FIELD FACILITIES

Table 1 source	Item	AQCR 1 Value	2 Value	3 Value	4 Value	5 Value	6 Value
C.1	E-Fraction of sites with environmental control						
C.3	S-Avg. Station Size (ft^2)						
	S/260						
E.10.a.	M-Mobile Units						
C.1	C-Pollutants classified Priority I						
	M_v-Value assigned for availability of mobile units						
E.5	T-Fraction of transportation available						

Multiply the value of each item (from Table 16) by the weight for that item in Table 17 and record the score for each item in each AQCR in Table 17.

TABLE 17. RATING FOR FIELD FACILITIES

Item	Weight	AQCR 1 Score	2 Score	3 Score	4 Score	5 Score	6 Score	Network sum/item
E	(0.28)							
S/260	(0.25)							
M_v	(0.19)							
T	(0.28)							
AQCR rating = Sum of Scores								
						Element R*		

* Sum the AQCR ratings, and divide by the number of AQCRs to derive the Rating of this element for the network.

IV.E FIELD INSTRUMENT RATING

The determination of Ratings for field instruments used to monitor the five major pollutants depends simply on whether the performance parameters of the network sensors (recorded in part E.9 of Table 1) are at least equal to those specified in CFR Part 40, Title 50, 1975b, and on the weight assigned to each parameter. This element is divided into two sub-elements, treated separately.

IV.E.1 Rating for Intermittent Sensors

Table 18 lists the performance specifications for intermittent sensors for three pollutants, as published in CFR Title 40, Part 50, 1975b. If the network sensor specification recorded in part 10.c of Table 1 is at least equal to that tabulated, the score is the indicated weight; if it does not meet the tabulated specifications, the score is 0. Sum the score for the sensor for each pollutant to derive the rating for each sensor. The sub-element rating for intermittent sensors is the sum of the total scores divided by the number of total scores.

TABLE 18. RATING FOR INTERMITTENT SENSORS AS APPLICABLE

Table 1
source: Part E.10.c.

	Performance specifications		Sensor for SO_2^*	Sensor for NO_2^*	Sensor for TSP
		Weight	Score	Score	Score
1.	Pump must maintain air pressure differential greater than 0.7 atmospheres at desired flow rate.	0.5			X
2.	A calibrated rotameter or critical orifice must measure air flow of 0.2 liters/min. within $\pm$ 2%	0.5			X
3.	Pump must draw air through an 8-x 10-inch filter at a rate between 40-60 cu.ft./min.	1.0	X	X	

* Score if used by network.

Total Score = ____ ____ ____

$$\frac{\text{Sub-element-rating}}{} = R_1 = \frac{\text{Sum of Total Scores}}{\text{No. of Total Scores}} = _____.$$

IV.E.2 Rating for Continuous Sensors

Use Table 19 (which lists the performance parameters for continuous sensors from CFR Title 40, Part 50, 1975b, and the weight assigned to each parameter) to derive the Ratings for continuous sensors for three pollutants. If the network sensor specifications listed in part E.10.b of Table 1 meet those tabulated, the value is 1; if not, the value is 0. The product of the weight times the value for each parameter is the score. Find the total score for each sensor, and the network score for continuous sensors, as indicated.

IV.E.3 Element Rating

The element Rating is the average of the two sub-element ratings:

$$\text{Element Rating for Field Instruments} = \frac{R_1(\text{Table 18}) + R_2(\text{Table 19})}{2}$$

$$R = \underline{\qquad\qquad\qquad\qquad}.$$

A Rating of 1 indicates that all field instruments meet Federal Register Specifications.

TABLE 19. RATING FOR CONTINUOUS INSTRUMENT PERFORMANCE PARAMETERS*

Table 1
source: Part E.10.b

Parameter	Units	Weight	$SO_2^{\dagger}$ Specs	$SO_2^{\dagger}$ Value	$SO_2^{\dagger}$ Score	Oxidants Specs	Oxidants Value	Oxidants Score	CO Specs	CO Value	CO Score
1. Range	ppm	0.094	0-0.5			0-0.5			0-50		
2. Noise	ppm	0.086	0.005			0.005			0.50		
3. Lower detectable limit	ppm	0.094	0.01			0.01			1.00		
4. Interference Equivalent											
Each interferent	ppm	0.05	±0.02			±0.020			±1.00		
Total interferent	ppm	0.05	0.06			0.060			1.50		
5. Zero drift, 12- & 24-hour	ppm	0.096	±0.02			±0.020			±1.00		
6. Span drift, 24 hours											
20% of upper range limit	%	0.047	±20.0			±20.0			±10.00		
80% of upper range limit	%	0.047	±5.0			±5.0			±2.5		
7. Lag time	min	0.068	20			20			10		
8. Rise time	min	0.068	15			15			5		
9. Fall time	min	0.068	15			15			5		
10. Precision											
20% of upper range limit	ppm	0.116	0.01			0.01			0.5		
80% of upper range limit	ppm	0.116	0.015			0.01			0.5		

* Specifications for each sensor taken from CFR, Title 40, part 53, 1975.

† Score if used by network

Total Score ____ Total Score ____ Total Score ____

Sub-Element Rating for Continuous Sensors = $\frac{\text{Sum of Total Scores}}{\text{No. of Total Scores}}$ = _____.

IV.F EVALUATION OF AREA OF FACILITIES AND EQUIPMENT

If the network operates a wet laboratory, follow Procedure 1 to evaluate the area of Facilities and Equipment. If sample analyses are performed on a contractual basis, follow Procedure 2. Both Procedures use the Ratings calculated in the Tables of this Section as values, which are then multiplied by assigned weights to provide Relative Ratings. The Relative Ratings are then summed to derive the area evaluation. Each Procedure tabulates the Source Table or Section listing the Rating, or value, for each element, along with the assigned weight for each element.

If the Rating of each element in the area is perfect (i.e., 1), the area evaluation will be 1, and each Relative Rating will equal the weight assigned to the element.

Procedure 1 for Area Evaluation

Source	Element	Element rating	x	Weight	=	Relative rating
Table 15,A	Office Facilities		x	0.082	=	
Table 15,B	Wet Lab. Facilities			0.149		
Table 15,B	Wet Lab. Instruments			0.145		
Table 15,B	Wet Lab. Instrument Quality			0.169		
Table 15,C	Calib./Maint. Facilities			0.169		
Table 17	Field Facilities			0.132		
IV.E.3	Field Instruments			0.154		
	Area Evaluation = Sum Relative Ratings =					

Procedure 2 for Area Evaluation

Source	Element	Element rating	x	Weight	=	Relative rating
Table 15,A	Office Facilities		x	0.153	=	
Table 15,C	Calib./Maint. Facilities			0.315		
Table 17	Field Facilities			0.246		
IV.E.3	Field Instruments			0.286		
	Area Evaluation = Sum Relative Ratings =					

SECTION V

EVALUATION OF AREA OF SAMPLING AND ANALYSIS

Only two elements will be examined in this area, Recording Procedures for Continuous Sensors and Efficiency of Use of Station Operator Time. Methods and procedures involved in Sampling Analysis will be considered in the area of Quality Assurance.

V.A RATING OF RECORDING PROCEDURES FOR CONTINUOUS SENSORS

The number of Priority I pollutants (the air quality indicators) in an AQCR is a factor that affects the importance of recording procedures used.

The "value" for each recording procedure is the percentage (expressed as a decimal fraction) of the continuous stations employing each procedure with two exceptions: (1) the value for strip charts is 1, since each continuous sensor must have strip chart recording; (2) if there is a digital acquisition system or a data processing system at Headquarters, the value is 1 (if not, 0) for each AQCR.

The weights for each procedure are listed in the left column of Table 20. Two weights are shown for strip-chart recording. If the AQCR is small, has less than two Priority I pollutants, and has only strip-chart recording, the weight is 1. If there are two or more Priority I pollutants, the weight is 0.410, since additional procedures are necessary.

The steps in the evaluational procedure follow. Use information from part C of Table 1 and record in Table 20.

V.A.1 Procedure Steps

Step 1

Record the number of Priority I pollutants in each AQCR in the space for each AQCR in Table 20.

Step 2

Multiply the values for strip charts by the appropriate weight, and record the results in the spaces on the line for r.

Step 3

Record the values for digital acquisition system at each station. Multiply the values times the weight in the left column, and record those results in the spaces on the line for r.

TABLE 20. EVALUATION OF CONTINUOUS SENSOR RECORDING PROCEDURES

		AQCR					
		1 No.Prior.I pollutant__	2 No.Prior.I pollutant__	3 No.Prior.I pollutant__	4 No.Prior.I pollutant__	5 No.Prior.I pollutant__	6 No.Prior.I pollutant__
Wt.	Procedure	Value	Value	Value	Value	Value	Value
1 or 0.410	Strip Charts	1.	1.	1.	1.	1.	1.
	r						
0.327	Digital Acquis. at Each Station						
	r						
0.263	Telemetry						
	r						
0.327	Digital Acquis. and Data Processing at Headquarters						
	r						
0.263	Only Data Processing at Headquarters						
	r						
R_i							
	R = _____						

Step 4

Record the values for telemetry. Multiply those by the weight and record the results in the spaces on the line for r.

Step 5

Record the value for digital acquisition system at Headquarters. Multiply that value by the weight and record the result in the spaces for r.

Step 6

Sum the values for r in each AQCR, and record those values in the spaces for R_i. The value of R_i is the rating for each AQCR, for recording procedures used. The perfect value for each R_i is 1.

Step 7

Sum the values of R_i and divide by the number of AQCRs evaluated, to obtain the value of R, and record the result, the network Rating for the element Continuous Sensor Recording Procedures. The perfect Rating is 1.

V.B RATING OF USE OF STATION OPERATOR TIME

In this element, an estimate is made of the use of station operator time based on the assumption that operators are not responsible for major maintenance and major calibration of sensors. The procedures of this evaluation follow as Steps, in which data from part C of Table 1 are recorded in Table 21, and calculations are made.

V.B.1 Procedure Steps

Step 1

On the first line of Table 21, record the number of continuous sensors in each AQCR.

Step 2

On the second line, record the number of station operators if continuous sensors are visited daily; record the number of operators multiplied by 2 if the sensors are visited every other day.

Step 3

Record the values of Step 1 divided by Step 2. In the spaces for r_1, record the product of value for each AQCR times the weight listed in the first column of the Table.

Step 4

Record the number of manual sensors in each AQCR.

Step 5

Record the number of station operators multiplied by 5 if manual sensors are checked once a week; record the number of operators multiplied by 2.5 if manual sensors are checked twice a week.

Step 6

Record the values of Step 4 divided by Step 5. In the spaces for r_2, record the product of value for each AQCR times the weight listed in the first column.

Step 7

Record the average miles/day traveled by operators visiting stations in each AQCR. In the spaces for r_3 record the product of Step 7 and the weight in the first column of the Table.

Step 8

Sum the values of r and record the sum for each AQCR in the space indicated.

TABLE 21. EVALUATION OF STATION OPERATOR TIME

Weight	Factor	AQCR 1	2	3	4	5	6
	1. No. Continuous Sensors						
	2. No. Station Operators						
0.38	3. Value						
	r_1						
	4. No. Manual Sensors						
	5. No. Station Operators						
0.16	6. Value						
	r_2						
0.03	7. Average Miles/Day						
	r_3						
	$r_1 + r_2 + r_3$						
	R_i						
	R =						

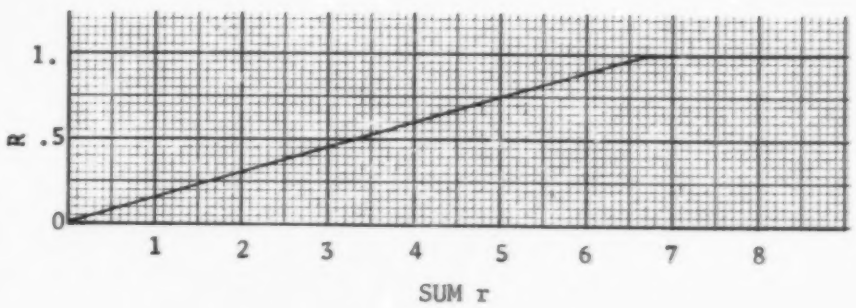


Figure 10. Rating for efficiency of use of station operator time

Step 9

On Figure 10, find the value of sum r on the horizontal axis and determine the value of R on the vertical axis. Record that value in Table 21 in the space for R_i for each AQCR. If each value of each R_i is 1, the station operation time is being used very efficiently.

Step 10

Sum the values of R_i, divide by the number of AQCRs, and record that value as R, the Rating for the element.

V.C AREA EVALUATION

Multiply the value of R in Table 20 by 0.50 = _____.
Multiply the value of R in Table 21 by 0.50 = _____.

Area Evaluation = Sum = _____.

The perfect area evaluation is 1. If the value is less than 1, the values, expressed as a percent, define how close the two elements are to perfect effectiveness.

SECTION VI

EVALUATION OF AREA OF QUALITY ASSURANCE

In this area, many aspects of quality control that affect quality assurance are evaluated. The area is divided into two major parts composed of several elements each. The first part considers controls on field instruments and measurements, the second part controls on laboratory instruments and measurements. The information needed should all be in the sections of Table 1, as referenced, and the Ratings and the area evaluation can be completed rapidly. General procedures rather than the specific details are considered to avoid an extremely lengthy period of information-gathering for Table 1. The perfect Rating for any element is 1, and the perfect area evaluation is also 1.

VI.A RATINGS FOR CONTROLS ON FIELD INSTRUMENTS AND MEASUREMENTS

Information to rate the elements of Field Instrument Calibration and Field Instrument Maintenance (on only four requirements each) is contained in the sections of Table 1 and is referenced in the first column of Table 22, for each item considered. The response in Table 1 (expressed as a decimal fraction) that indicates the percent conformance with requirements is the value of each item. The value of each item multiplied by the listed weight provides the score for that item. The sum of the scores within an element is the Rating for the element.

VI.A.1 Procedure Steps

Step 1

In Table 22, determine the value of the first item in the first element, Field Instrument Calibration, by reference to Section E.8.a of Table 1. In that tabulation, if the manufacturer's recommendations were used for frequency of instrument calibration of all instruments, the value of the item is 1. If they were used for only a fraction of the instruments, the value of the item is that fraction, expressed as a decimal. The value of the item, Documentation of Calibration Results, is determined in the same way, as is the value for Use of Documentation to Modify the Schedule. The value for Use of Approved Techniques will be 1 if all the procedures are those specified in CFR Title 40, Part 50, 1971, amended 1975b, and CFR Title 40, Part 53, 1975, or in U.S. EPA, 1971, or in Jutze, 1973, and if the equipment used is approved. If only a portion of the methods is as specified, the value of the item is that portion expressed as a decimal.

TABLE 22. RATINGS FOR CONTROLS ON FIELD INSTRUMENTS AND MEASUREMENTS

Each element Rating is the sum of the scores of the items within the element. Each score is the value of the item, multiplied by the indicated weight. The column labeled "Table 1 source" references the section of Table 1 providing information on the item value. Convert all percentages to decimal fractions before entering in the value column.

Table 1 source	Item	Value x Weight = Score	Element rating
	1. Field Instrument Calibration		
E.8.a.	Use of Mfr. Frequency Recommendation	x 0.188 =	
E.8.a.	Documentation of Calibration Results	0.287	
E.8.a.	Use of Documentation to Modify Schedule	0.237	
E.8.a.	Use of Approved Techniques	0.288	
		Sum of Scores = R =	
	2. Field Instrument Maintenance		
E.8.d.	Use of Mfr. Recommendations	0.204	
E.8.d.	Documentation of Maintenance	0.277	
E.8.d.	Use of Documentation to Modify Schedule	0.242	
E.8.d.	Use of Approved Techniques	0.277	
		Sum of Scores = R =	
	3. Controls of Field Measurements		
E.8.c.	Validation and Documentation of Secondary Standards	0.193	
E.9.	Use of Statistical Control Charts	0.172	
C.2.	Maintenance of Log Books	0.239	
C.6.	Documentation of Down Times (sum for all AQCRs)	0.168	
E.8.d.	Preventative Maintenance	0.228	
		Sum of Scores = R =	

Step 2

Rating of the element of Field Instrument Maintenance is performed in the same way, using the referenced sections of Table 1.

Step 3

Rating of the third element, Controls on Field Measurement System, is performed similarly. If items are not documented, the value is 0.

VI.B RATINGS FOR CONTROLS ON LABORATORY INSTRUMENTS AND MEASUREMENTS

Information to Rate the three elements considered in Controls on Laboratory Instruments and Measurements is in Table 1. Table 23 is provided for the calculations, which are similar to those in Table 22, and the first column references the location of the information in Table 1.

VI.B.1 Procedure Steps

Step 1

The Rating of Laboratory Instrument Calibration in Table 23 is based on the sum of the group of four items, information for which is all in part E.6 of Table 1. As in the previous evaluations, the value of each item is 1 if the requirement is met for every instrument, or the decimal fraction of 1 equal to the portion of instruments for which the item is used.

Step 2

Values of items in the next element, Factors Affecting Laboratory Supplies, depend on the following: the percent of the time that standard procedures are used in the handling and storage of chemicals, reagents, and gases; the percent of standard chemicals and gases for which values are validated; the maintenance of an inventory of supplies (value is 1 if yes, 0 if no); and whether the quality of purchased supplies is checked (value is 1 if yes, 0 if no). All the needed information should be in the referenced sections of Table 1.

Step 3

Values of items in the element, Controls on Laboratory Measurements, depend on answers in the referenced sections of Table 1. The value of the first item depends on whether the analytical methods used are referenced in CFR Title 40, Part 50, 1971, amended 1975b, and CFR Title 40, Part 53, 1975. If all methods are referenced, the value is 1; otherwise, the value is the decimal fraction representing the portions of the methods that are referenced. If there is scheduled participation in interlaboratory testing, the value of the item is 1, if not, the value is 0. If there are check list controls on the electrical service, the value is 1, if not the value is 0. If 10 percent or more of all samples undergo replicate analysis, the value is 1. If the percentage is less, the value is the decimal fraction equal to the actual percentage divided by 10 percent.

TABLE 23. RATINGS FOR CONTROLS ON LABORATORY INSTRUMENTS AND MEASUPEMENTS

Each element rating is the sum of the scores of the items within the element. Each score is the value of the item multiplied by the indicated weight. The column labeled "Table 1 source" references the section of Table 1 providing information on the item value. Convert all percentages to decimal fractions before entering in the Value column.

Table 1 source	Item	Value x Weight = Score	Element rating
	1. Laboratory Instrument Calibrations		
E.6.j.	Frequency as Mfr. Recommends	x 0.200 =	
E.6.j.	Documentation of Calibration Results	0.281	
E.6.k.	Use of Documentation to Modify Schedule	0.237	
E.6.l.	Use of Approved Techniques	0.282	
		Sum of Scores = R =	
	2. Factors Affecting Laboratory Supplies		
E.6.c.& d.	Handling Procedures	0.188	
E.6.c.& d.	Storage Procedures	0.186	
E.6.e.	Validation of Chemical and Gas Standards	0.241	
E.6.h.	Maintenance of Inventory	0.161	
E.6.i.	Check Quality of Purchased Supplies	0.224	
		Sum of Scores = R =	
	3. Controls on Laboratory Measurement		
E.7.a.	Use of Approved Techniques	0.193	
E.7.b.	Use of Statistical Control Chart Techniques	0.115	
E.7.c.	Interlaboratory Testing	0.192	
E.7.d.	Validation of Data	0.192	
E.6.b.	Controls on Electrical Service	0.154	
E.7.e.	Replication	0.154	
		Sum of Scores = R =	

VI.C. EVALUATION OF THE AREA

In Table 24, record the values of the products of the Rating for each element of this area and the weight listed for that element. The sum of the products determines the area evaluation.

TABLE 24. AREA OF QUALITY ASSURANCE EVALUATION

Source table	Element	Rating x Weight = Rel. E.
22	Field Instrument Calibration	x 0.212 =
22	Field Instrument Maintenance	0.152
22	Controls on Field Measurement	0.172
23	Laboratory Instrument Calibration	0.186
23	Factors Affecting Lab Supplies	0.116
23	Controls on Lab Measurements	0.162 _____
	E = Area Evaluation = Sum =	

SECTION VII

EVALUATION OF AREA OF DATA UTILIZATION

In this area, the utilization and distribution of monitored data are examined. Information to allow evaluation of the four elements of the area should be found in parts C and D of Table 1, and Table 25 is provided for the evaluation of each item and element.

1. The score for each item in each of elements A, B, C, and D of this area is the value of the item multiplied by its weight. The value of each item depends on the responses to the questions in part D, Table 1. If the response is yes, the value is 1; if the response is no, the value is zero. Weights for the items of elements A, B, and C are given in Table 25. Weights for the items of element D, Timely Preparation of Data Summaries, are determined from Fig. 11, which contains two figures, one for monthly summaries and one for quarterly summaries. Note that the time of summary release should be earlier if computerized analysis is available. The availability of computerized analysis is indicated in part C, of Table 1. If Headquarters digital acquisition has been checked in part C of Table 1, then use the computer analysis "curves" to determine the weights. If not, use the manual data reduction "curves" to determine the weights.

2. The Rating for each element is the sum of the scores, as indicated in Table 25, and the area evaluation is the sum of the Ratings for each element, divided by 4.

$$E = \frac{\text{Sum of R's}}{4} = _____.$$

TABLE 25. RATINGS FOR DATA UTILIZATION

Table 1 source	Item	Value x Weight = Score	Element rating
	A. Public Information		
1.D.	Daily release of air quality information to public media	x 0.5 =	
1.D.	Publication of air quality reports for release to public	0.5 ____	
		Sum of Scores = R	= ____
	B. Forecasting and Modeling		
1.D.	Use of data to validate or calibrate an air model	0.625	
1.D.	Use of data to predict trends	0.375 ____	
		Sum of Scores = R	= ____
	C. Maintenance of Air Quality		
1.D.	Use of data to evaluate air quality and detect changes	1. ____	
		Sum of Scores = R	= ____
	D. Timely Publication of Data Summaries		
1.D. and 1.C.1.	Preparation of quarterly data summaries and monthly data summaries	____ ____	
		$\frac{\text{Sum of Scores}}{2}$ = R =	____

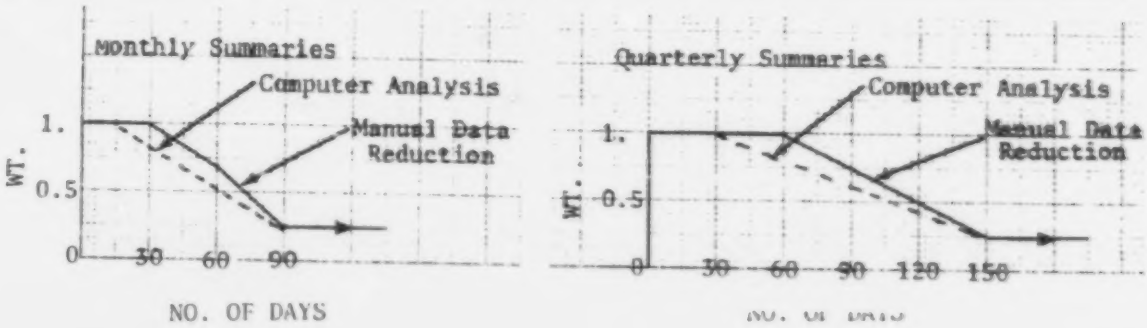


Figure 11. Days between end of period and summary release

SECTION VIII

OVERALL AREA EVALUATIONS

To determine an evaluation for the network for all the areas examined, multiply the area evaluation determined at the end of each Section by the weight listed in Table 26. The sum of these products is the overall Network Evaluation. Each product represents a Relative Evaluation. The closer each Relative Evaluation is to the listed weight, the closer the area effectiveness, with respect to overall operations, is to optimum, in the opinion of the Survey Letter responses.

TABLE 26. NETWORK EVALUATION

AREA	Area Evaluation x Weight = Relative Evaluation
I. Plan and Design	x 0.182 =
II. Personnel	0.165
III. Facilities and Equipment	0.167
IV. Sampling and Analysis	0.173
V. Quality Assurance	0.182
VI. Data Utilization	0.131
Network Evaluation = Sum of Scores =	

The value of 1 represents a perfect score, for each area and for the network; i.e., the network is operating at 100 percent effectiveness. Where a value is less than 1, the cause of lack of effectiveness should be examined for improvement.

SECTION IX

EVALUATION OF TECHNICAL SERVICES BUDGET ALLOCATION

IX.A BUDGET ALLOCATION RATING DETERMINATION

IX.A.1 Procedure Steps

Step 1

Record the budget allocation to Engineering-Enforcement listed in part A of Table 1. _____

Step 2

Record the budget allocation to Technical Services, listed in part A of Table 1. _____

Step 3

Divide Step 2 by Step 1. _____

Step 4

Record the budget allocation to Technical Services Personnel, listed in part A of Table 1. _____

Step 5

Divide Step 4 by Step 2. _____

Step 6

Locate in Figure 12 the value of the intersection of Step 3 along the horizontal axis and the value of Step 5 along the vertical axis. If the point lies in the shaded region, follow the procedures of Step 6.a; if the point lies below the shaded region, follow the procedure of Step 6.b.; if the point lies above the shaded region, follow the procedures of Step 6.c.

a. If the point lies in the shaded region, enter the value 1.0 in Step 7.

b. Determine the vertical axis value of a point on curve A immediately above the calculated point. In the lower half of Figure 13 find the r_i^* curve closest to this vertical axis value. On this r_i^* curve, locate the value determined in Step 5 along the horizontal axis.

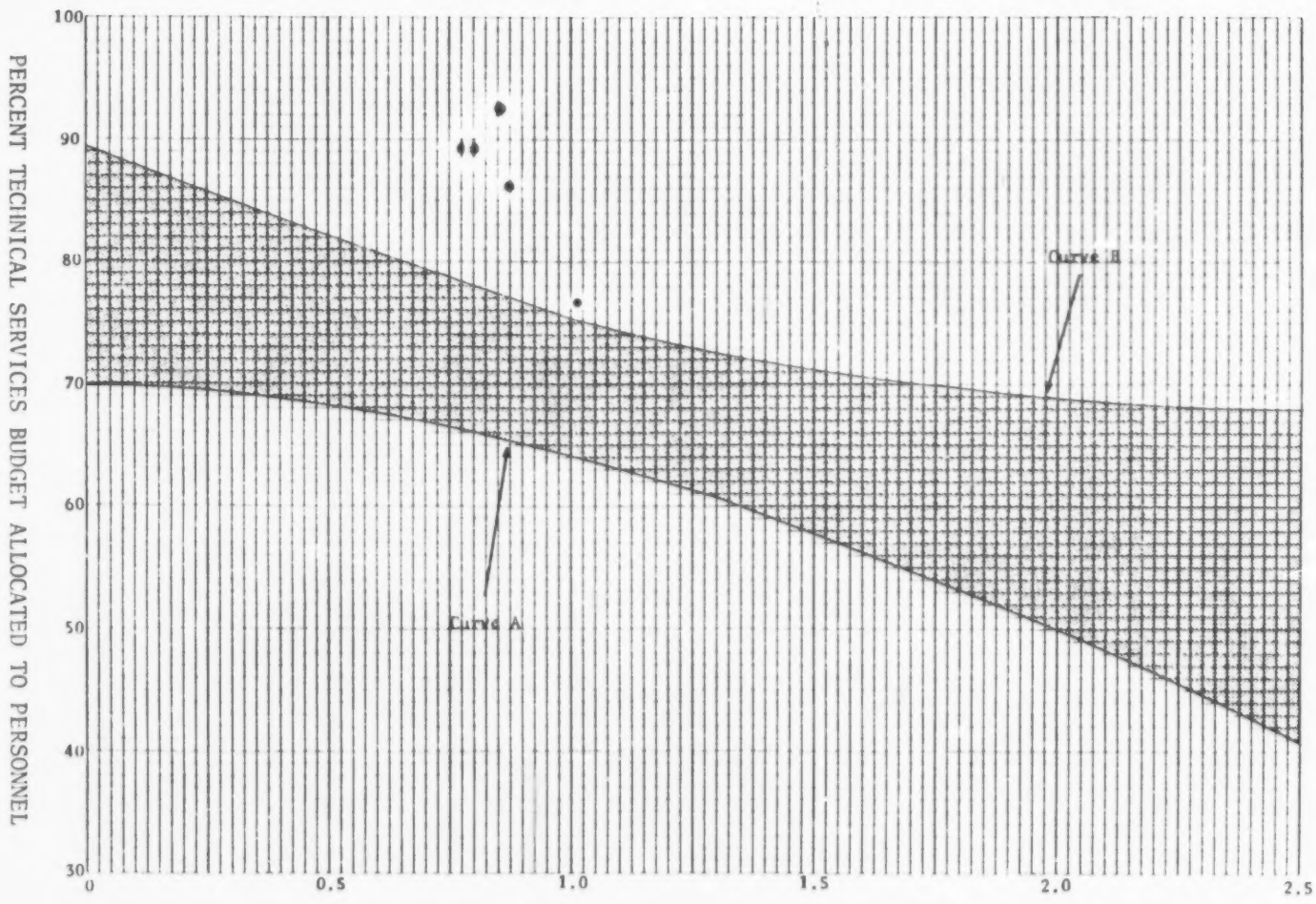


Figure 12. Determination of technical services budget allocation

Then read the Budget Allocation Rating for this point on the vertical axis. Record this Budget Allocation Rating in Step 7.

c. Determine the vertical axis value of a point on curve B immediately below the calculated point. In the upper half of Figure 13 find the r_1^* curve closest to this vertical axis value. On this r_1^* curve, locate the value determined in Step 5 along the horizontal axis. Then read the Budget Allocation Rating for this point on the vertical axis. Record the Budget Allocation Rating in Step 7.

Step 7

The value determined in Step 6 is the evaluation of the Technical Services Budget Allocation. _____

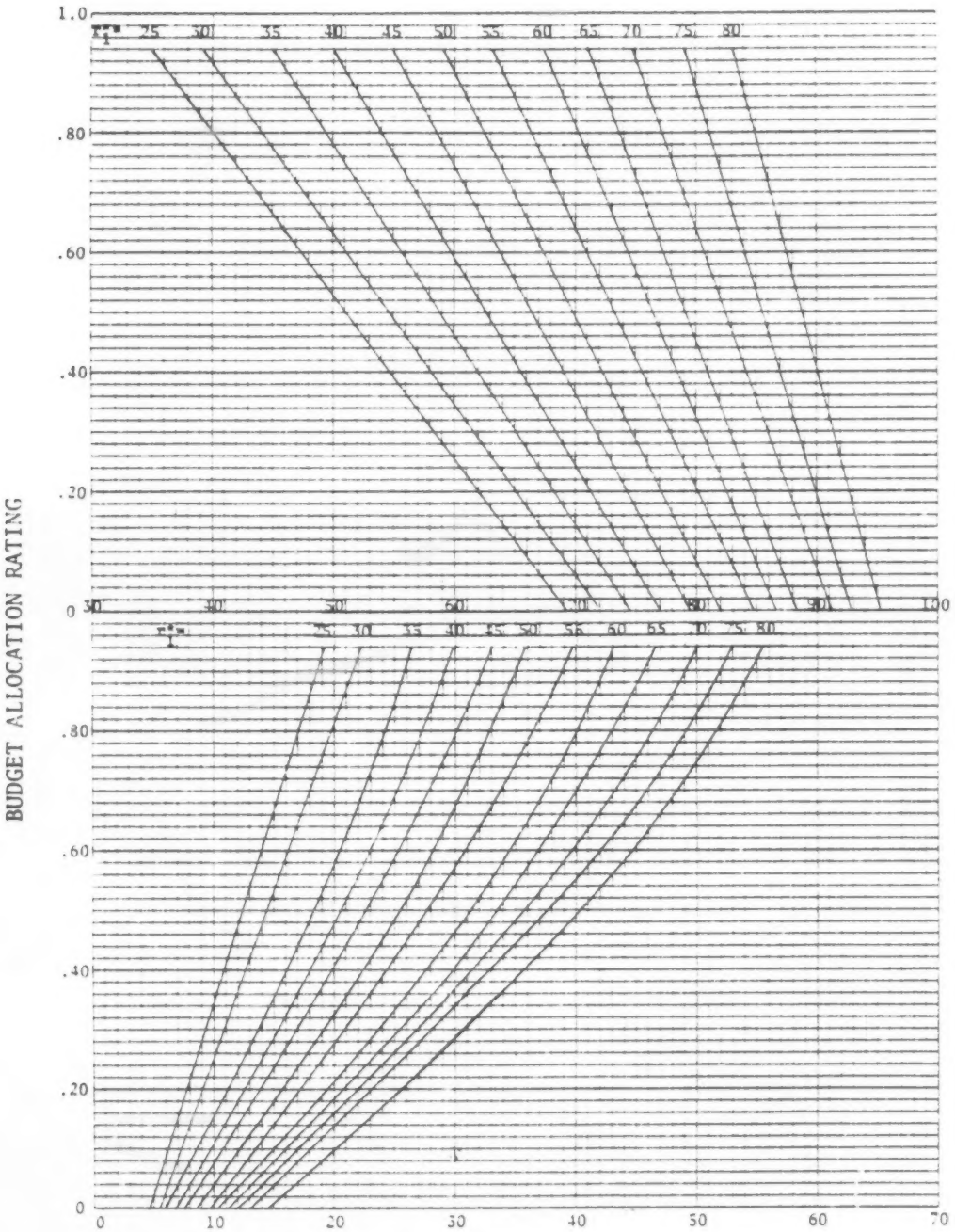


Figure 13. Personnel budget allocation rating

SECTION X

REFERENCES

Code of Federal Regulations (CFR)

Title 40, Part 51.17, "Air Quality Surveillance," November 25, 1971, including amendments through February 18, 1975a.

Title 40, Part 53, "Ambient Air Monitoring Reference and Equivalent Methods," February 18, 1975, with changes of April 25, 1975.

Title 40, Part 50, "National Primary and Secondary Air Quality Standards," November 25, 1971, including amendments through February 18, 1975b.

Jutze, George A., et al., Quality Control Practices in Processing Air Pollution Samples, Office of Air Programs Publication No. APTD-1132, EPA, Research Triangle Park, N.C., March 1973.

U.S. Environmental Protection Agency:
Field Operations Guide for Automatic Air Monitoring Equipment, Office of Air Programs Publication No. APTD-0756, EPA, Research Triangle Park, N.C., November 1971.

Guidance for Air Quality Monitoring Network Design and Instrument Siting, Office of Air Quality Planning and Standards and the Quality Assurance and Environmental Monitoring Laboratory Publication OAQPS No. 1.2-012, Research Triangle Park, N.C., January 1974.

Guidelines for Technical Services of a State Air Pollution Control Agency, Office of Air Programs Publication No. APTD-1347, Research Triangle Park, N.C., November 1972.

APPENDIX A

CONVERSION FROM NON-METRIC UNITS TO SI* UNITS

Non-SI unit	x	Conversion factor	=	SI unit
length				
ft.		0.3048		m
in.		2.54×10^{-2}		m
mi.		1.609×10^{3}		m
area				
sq. ft.		0.09290		m^2
sq. mi.		2.590×10^{6}		m^2
velocity				
$ft.^3$/min.		0.02832		m^3/60 s
mi./day		1.609×10^{3}		m/24 h

*International System of Units

According to the Metric Practice Guide and Style Manual, published in 1975 by the International Bureau of Weights and Measures, the use of standard atmosphere has been authorized, for a limited time. The SI definition is:

1 standard atmosphere = 101,325 newtons per square metre, (N/m^2).